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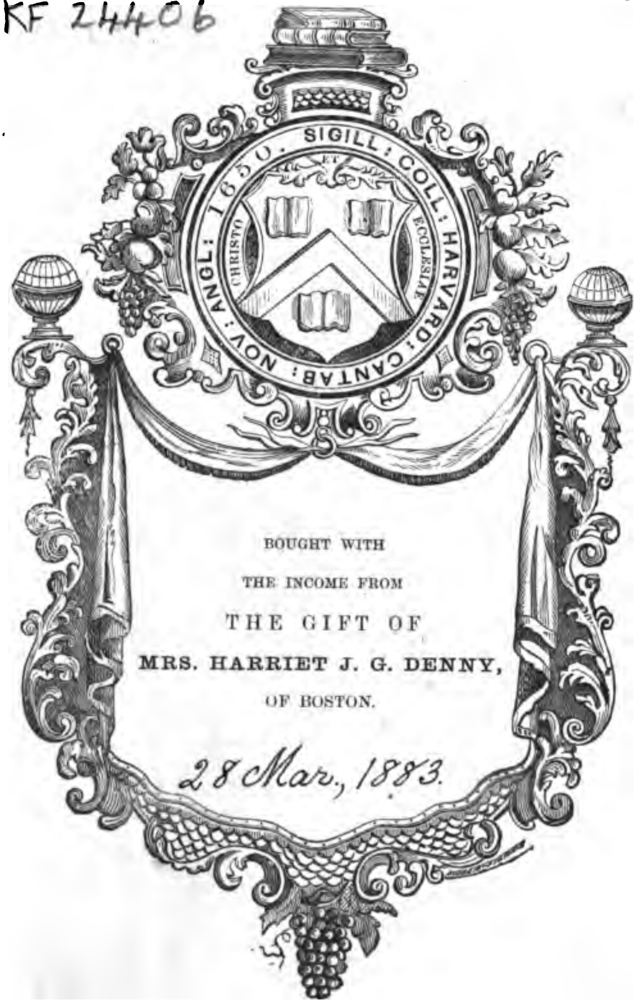
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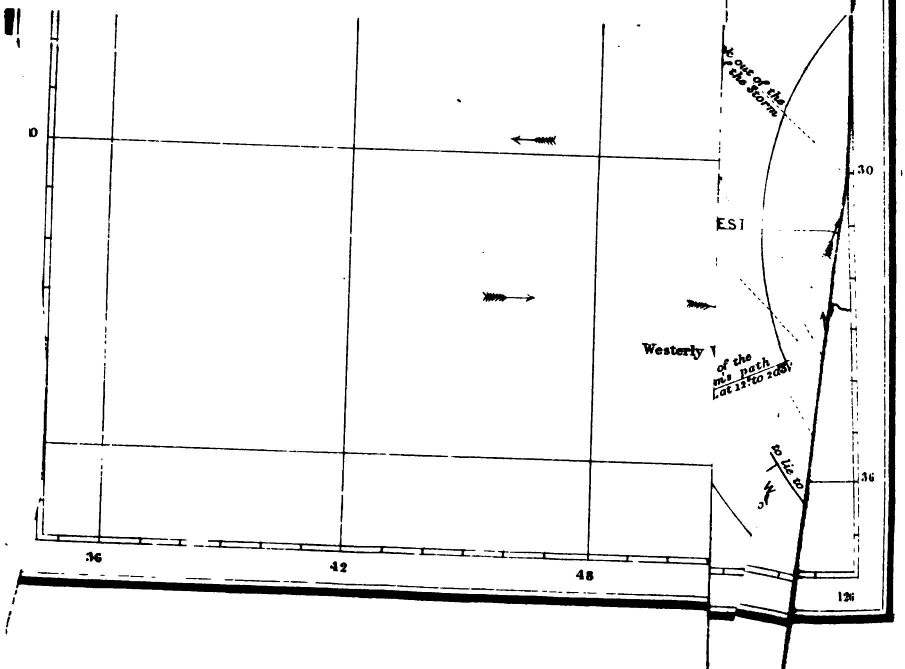
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AN INQUIRY

INTO THE

NATURE AND COURSE OF STORMS

IN THE

INDIAN OCEAN SOUTH OF THE EQUATOR;

WITH A VIEW OF DISCOVERING THEIR
ORIGIN, EXTENT, ROTATORY CHARACTER, RATE AND DIRECTION
OF PROGRESSION, BAROMETRIC DEPRESSION, AND
OTHER CONCOMITANT PHENOMENA;

FOR

THE PRACTICAL PURPOSE

OF

ENABLING SHIPS TO ASCERTAIN THE PROXIMITY AND RELATIVE
POSITION OF HURRICANES;

WITH

SUGGESTIONS ON THE MEANS OF AVOIDING THEM.

By ALEXANDER THOM,
SURGEON 86TH, ROYAL COUNTY DOWN REGT.

LONDON:
SMITH, ELDER AND CO., CORNHILL.

MDCCCXLV.

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PREFACE.

The following work is chiefly intended for officers navigating vessels in the Indian Ocean, in the hope of being able to convince the doubtful, and force on the attention of the heedless or ignorant, the real nature of those dangers from which both shrink with awe and undefined dread, and to show that the means of avoiding them are neither uncertain nor difficult. It may also assist the intelligent and inquiring officer, whose arduous duties at sea, and brief and hurried visits to land, leave him little time to accumulate facts, or pursue a subject so intimately connected with his profession.

At the same time, should these pages find their way into the hands of general readers, it may disclose the difficulties which still beset the study of storms, and show how little is yet really known, and how much more remains to be discovered; and perhaps induce some of those lofty understandings now devoted to more fascinating branches of science to rescue it from the neglect in which, notwithstanding the energetic impulse given to it by Reid, it still rests in this country. The profound importance of the science of storms is too palpable, and too painfully brought home to the mind and feelings of every one, to require comment or apology for bringing it before the public.

While stationed at Mauritius, from which the author has recently returned, he gave some attention to the subject of hurricanes merely as an abstract question, the duties and nomadic life of a military medical officer being unsuitable to the pursuit of a study claiming so much time, and, above all, a prolonged residence at places where the requisite information can be gathered.

Being at Port Louis, and about to leave the island of Mauritius, when the vessels wrecked in the Rodriguez hurricane of 1843 put in there to refit, he drew up the diagrams of its course and rotatory action, partly to ascertain the truth of the theory, and partly to demonstrate its real character to some of the parties engaged in it, while the event was still fresh in their memory. During a voyage to England he devoted his time to investigate the nature and probable causes of this and other storms in the Indian Ocean, when the substance of the following pages was drawn up in the form of detached papers, without any view to publication. But in consequence of some distinguished naval officers, who examined the diagrams and notes, having warmly expressed their opinion of the practical utility likely to be derived from their publication, he determined to follow their recommendation. For this purpose he endeavoured, during a few hasty and brief visits to town, to collect as many additional facts as possible, and had that gratifying stimulus to proceed which arises from finding every new case corroborating the results previously obtained; and the more complete the details, so much more fully was the immutability of the laws which govern tempests made out.

Before this could be achieved, the author was appointed to a regiment in India, and received orders to hold himself in readiness to proceed to Scinde. At such a station, little time or opportunity could be expected for the completion of the work. In this dilemma he must either have left his notes unpublished, or let them go forth to the world in their present form. The latter course has been ventured on, and thus, amid the unrelaxing duties of Chatham garrison, and unavoidable interruptions connected with his profession, wholly preventing that concentration of time and thought necessary for such a subject, they have been prepared for the press.

The Author thinks this explanation due to himself as well as to his readers, to account for the hurried manner in which the work has been brought before the public, unsupported by more extensive research, and without that thorough revision and literary emendation, which enhance the value of the most common-place statements.

It has been his aim to preserve simple facts and their practical application distinct from hypothesis. In a science yet in its infancy, where the results are deduced rather from the multiplicity of these than from their separate accuracy, great nicety cannot be attained, nor is it possible, without interrupting a clear view of the whole, to adhere to fractional minuteness with that rigorous exactitude which belongs to other branches of Philosophy.

When a complete system of observation is instituted by some body of men,—for individual exertion must ever be very restricted,—and time, place, and force are correctly represented by figures, then may the theory of storms be verified, and fixed on a substantial basis. If even the loose, casual, and isolated facts within our reach yield such unvarying results, what may not be expected from a series of minute and precise observations?

From the very nature of the following inquiry, it is almost impossible to avoid hypothetical reasoning. In fact, the adoption of a theory, founded on recognised principles, facilitates the investigation of abstruse subjects and the arrangement of facts in that relation which analogy would indicate to be their natural position. Without the aid of some settled opinions to guide us, the more important phenomena may frequently pass unnoticed, while others, because they strike more forcibly on our senses as objects of awe or wonder, attract too prominent attention. Yet, after all, the object of accumulating facts is to render them subservient to the discovery of those principles on which they depend, and both are so necessarily connected that it is impossible to pursue either separately with advantage.

The Author takes this opportunity of acknowledging the encouragement he has received from some of the officers of her Majesty's Navy; and also of offering his thanks to those of the Merchant Service, who have promptly offered every assistance in their power to forward the objects in view; as well as to Messrs. Green and Co. and others, who have freely permitted him to examine their valuable collection of log-books. He only regrets that he has not had time or ability to do justice to the matter which has been placed at his disposal.

He concludes with the earnest hope, that officers in command of ships, when traversing the Indian Ocean during the hurricane months, will be careful to have the *veering* and *precise direction of the wind; the state of the weather; appearance of the sky, and clouds; condition of the sea,* and *direction of any remarkable swell;* with *the height of the Barometer and Sympiesometer,* &c. noted as fully as possible, in connexion with the *exact latitude and longitude.* Nor is this of less importance when a vessel may have fine weather; for it is by the information gathered from ships at a distance from a hurricane, that its extent and path can be traced; besides, they are more likely to be correct in their reckoning than those which may be tossing about within its influence. It may herein be seen that log-books are not mere uninteresting documents only fit to be thrown aside when a voyage is over, but that from their pages valuable matter may be gleaned; and perhaps the knowledge that old logs can be made useful, and may occasionally meet the public eye, will induce the writers to note, with accuracy and minuteness, points which hitherto, being considered of no consequence, have been neglected, or recorded with that carelessness too often engendered by the daily routine of common-place duties.

Chatham, *June* 20, 1845.

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132, — 17, *for* parallelepoid, *read* parallelogram.
133, — 7, *for* of the same, *read* at the same.
138, — 1 note, *for* coastward, *read* eastward.
168, — 17, *for* vortical, *read* vertical.
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ON THE

HURRICANES OF THE INDIAN OCEAN.

SECTION I.

PRELIMINARY REMARKS.

The Island of Mauritius, although a mere speck on the Indian ocean, is, for its size, one of the most valuable of our colonies, and it is in the power of the parent state to render it still more important. Independently of the richness and fertility of the soil, and regarded merely as a military position in the line of communication with our colossal Indian empire, it is absolutely essential to the protection of our commerce in time of war, while, in another point of view, it is invaluable as a place of shelter for vessels which have suffered from the tempests so frequent in those seas.

Very little appears to be generally known of this beautiful island, and yet it is inferior to few places in productiveness of soil and scenic attraction. Within the circumference of ninety miles, it embraces almost every variety of surface, from the low and rich plains, to the rugged and inaccessible peaks crowning the lofty and picturesque ranges of mountains which intersect it from shore to shore. The deep ravines which everywhere intercept the traveller who wanders from the beaten tracks, seem to be the result of convulsive rendings of the plains and table land, and abound in streams which dash over the precipitous ledges in a succession of cataracts many hundred feet in height,* till they reach the sea. Nature has clothed this island in a garb of luxuriant vegetation, peculiar to a tropical country. The great variety of climate embraced by a range of 2000 feet from the level of the ocean to the more elevated parts of the island, is favourable for the cultivation of seeds and plants from every part of the world. A ride of two hours will carry the visitor from plains covered with sugar canes, the clove and spice tree, pine apple and banana, to a region where he will see wheat, European fruits, and the homely but not less valuable vegetables of old England.

Beneath this gay covering the geologist will find an interesting field for research and speculation on the mighty forces which must, at some early period of the world, have been in terrible activity, as is evidenced by the yawning chasms, riven mountains, and silent craters. Here may be traced the successive stratifications formed by a submarine volcano, to which alone can be attributed the singular positions of many of the higher peaks of the mountains, such as the Pieter Both. Nor did these agencies cease with that great effort which left a blackened heap of lava overlooking the waters of the ocean, for there is ample proof of the recurrence of volcanic action in the irruptions of basalt, forming the gentle slopes and smooth plains now studded with the habitations of man.

But leaving these primeval phenomena to the investigation of the geologist, the Island of Mauritius is subject to visitations of another kind, which, if less appalling, are rendered by their violence and constant recurrence, objects of great dread to its inhabitants. We allude to the destructive hurricanes which from time to time involve the country in ruin and desolation. The planter has not only to contend with all the evils common to agriculturists in every country, but his anxiety is constantly kept alive by the possibility of the whole fruit of his year's toil being destroyed in a few hours, and the crops perhaps left as manure on the spot where they grew. Nor are the disasters arising from these tempests confined to the open fields; buildings are overthrown, roads and bridges are swept away, cattle are drowned, and magazines destroyed. And yet it is surprising how quickly the traces of a hurricane are effaced from the cultivated parts of the country by the energy of tropical vegetation, and the activity of human industry. It is somewhat different, however, in those parts which are abandoned to the dominion of nature, where the visitor will find indelible traces of the storms. The forests are strewed with the trunks of vast trees, which had resisted the elements till they attained a magnitude which might seem to defy further assaults. So quickly are the wrecks of these noble trees overrun by exuberant vegetation, that their very existence escapes the notice of the careless traveller. But let those who desire to witness the effects of bygone hurricanes, visit the clearances recently made by the emancipated blacks among the recesses of the woods. Even without quitting the paths that intersect the truly primeval forests of the Isle of France, the stranger will find his attention arrested by groups of gigantic trunks, made bare and branchless by successive storms, which are seen towering far above the rounded green summits of the younger trees. Nor is the effect diminished by the numerous and beautiful creeping plants peculiar to the island, which clasping these riven giants of the forest, ascend to the highest point, and are seen waving gracefully in the breeze, or stretching in festoons to the neighbouring branches.

---

* The fall of the Chamarelle is 350 feet high, others not much less.

Even the mountain ridges retain vestiges of these terrific tempests. Huge masses of rock, loosened by the rain, and almost shaken by the wind, are seen

——— "tottering o'er the hollow pass,
" As if an infant's touch could urge
" Their headlong passage down the verge."

The cliffs are undermined, the banks swept away, and the ravines become more deeply furrowed by the mighty rivers, of which, during a hurricane, they are made the channels.

On the coasts we meet with enormous masses of coral rock, torn from their parent beds in the depths of the sea, and thrown high on the embankment of sand which girts the island. Such is the magnitude of many of these blocks, that it is difficult to conceive how the mere force of water in motion could have removed them to their present position.

Here it may not be altogether out of place to advert to those curious and isolated masses of coralline formation, which are found at the distance of a mile from the sea-coast, and are scattered about the cane-fields, at the southern extremity of the island, particularly between Mahêbourg and the Morne. The largest which we remember is about forty feet long, twenty broad, and fifteen high, and rather of an oval form, as if it had been rolled. It lies on the estate of Beauchamp, in the Savanne, about half a mile from the present margin of the sea, but not more than 300 yards from the edge of the basaltic stratum, on which it now rests, where the boundary of the ocean was, in former times, the intermediate space having been formed by the debris of the coral reefs. Other ponderous masses of the same kind occur along the coast at various distances from the sea. On the plain to the eastward of Souillac, may be seen several of these detached blocks, lying on a stratum of basalt, forty or fifty feet above the level of the ocean, and terminating at the beach in perpendicular cliffs, equally high.

A very general opinion prevails in Mauritius, that these have been conveyed to their present resting places, by the combined action of the waves and wind during a storm; but we have never met any one who had ocular demonstration of such a fact, and are inclined to think the explanation is scarcely adequate to the phenomenon. The ocean, agitated by a tempest, is capable of tearing up the coral beds, and throwing masses of them on the coast; but what combination of wind and waves could lift a block of some thousand tons weight to the height of thirty or forty feet up the face of a precipitous cliff, and send it rolling over a plain for half a mile? Yet these bodies are beyond question of marine origin, and being composed of the organic remains of the coralline and molluscous tribes, which at the present day inhabit and are at work on the coasts; there is no difficulty in identifying them as part of the modern reefs. But for the proofs of their recent formation, we might have supposed that they had been carried to their present situations by a sudden rise of the ocean, incident to those disturbances of a volcanic nature which were of frequent occurrence in the earlier ages of the island. And yet the transportation of these bodies by hurricanes is quite reconcilable with the extraordinary accounts of the force of whirlwinds, and other vortical commotions of the atmosphere, which are current on the spot.

It has been said that hurricanes occur less frequently, and with diminished severity, at Mauritius than formerly; but there is no good reason for believing that this is the case. Facts prove that they visit the same latitudes with a surprising regularity of recurrence, and, if the opinions advanced in the subsequent pages be based on truth, may be expected to do so while the present laws of the universe remain. A season never elapses without two or three of these tempests passing near, if not over, the island, attended by such a state of the barometer, wind, and sea, as leaves little doubt of their proximity, and in several instances, by means of collateral information, we have been successful in confirming the correctness of what were at the time mere suspicions. In fact it will be seen as we proceed, that an almost continued succession of stormy commotions follow one another, with different degrees of violence, along the tract of ocean between the Indian Archipelago and the east coast of South Africa. It is likewise a fact, that this period never passes without a number of crippled ships putting into the island to repair damages sustained from hurricanes in its neighbourhood, or a little farther to the N.E. of it. Yet it often happens that for several years no storm of this nature is supposed by the inhabitants to take place. The reason is simply this—that although the wind is blowing round a vast progressive circle of from 300 to 600 miles in diameter, it is only within 100 miles or so of the vortex that its violence is increased to such a degree as to constitute a hurricane. Thus, when a portion of this moving disc of air impinges on the island, and the barometer merely falls in a partial degree, and the wind veers but a quarter of the compass, it is only considered as threatening; while, thirty or forty leagues off, ships are losing their masts. Look at the harbour of Port Louis, on one side blocked up by the hulls of sunken and sinking vessels, driven in by storms, encountered on the open ocean, in so wrecked a condition, that the expense of repairing them would amount to more than a new ship, in other and less expensive places. Indeed, this circumstance has earned for Port Louis a no very enviable reputation for the facilities which it furnishes, in condemning disabled craft; the injustice of the charge could easily be shown by adducing the very great expense connected with everything in the shape of labour in Mauritius; a result of the ill-judged and almost cruel interdict laid on the introduction of cooly labourers, at a moment when the inhabitants were deprived of the services of the black population, by what was, in itself, one of the noblest acts of justice which adorn the page of English history.

Considering the annual loss of property, and too frequently of life, it is surprising that so little has been done to discover some means by which vessels may be enabled to shun the perils which are incidental to hurricanes. To Mr. Redfield, in America, and Colonel Reid, in our own country, is due the merit of opening up a course of investigation, with regard to the nature of rotatory gales, which, if closely pursued, cannot fail of ultimate success in the great object sought for—the means of avoiding them. The vital importance of the question is beyond dispute. To us, as a great commercial nation, whose ships cover the ocean, and might almost repeat our signals round the globe, it is fraught with deeper interest than to any other power. But although the interest of all, it seems to be the province of none, to follow up the subject as it merits. For one vessel that rounded the Cape of Good Hope thirty years ago, there are now three or four, and from their diminished tonnage, and perhaps, occasionally, less efficient equipment, they are not so fit to contend with those fearful tempests that have not spared our line-of-battle ships and huge East Indiamen. The very name of Mauritius is associated in our recollection with a series of fearful catastrophes at sea. To say nothing of the number of noble vessels with whose fate we are but imperfectly acquainted, how many more

> "To the winds of the ocean have left their wild story."

At the moment that we write, hundreds of hearts are filled with intense anxiety regarding the fate of ships which are known to have entered the hurricane latitudes of the Indian ocean, but which, after a more than usual lapse of time, have not been heard of.

In the West Indies, and on the Coast of America, there are so many fixed points for simultaneous observation, that the study of hurricanes may be pursued with a very near approach to accuracy. It is quite different in the Indian seas, south of the equator, where, over a wide expanse of some thousand miles, but one or two distant and isolated points for observation occur, and only at one of these is there reason to expect much information. Yet this tract is constantly covered with ships between India and the Cape, and may, in fact, be considered as the great highway of our commerce with the east. While so much attention is paid to the useful object of surveying distant coasts and seas, might it not be extended to the equally important purpose of investigating the nature of those tempests which involve so awful a destruction of human life, as well as of valuable property?

A line of posts of observations might easily be established across the Indian ocean, at Port Natal, Bourbon, Mauritius, Rodriguez, Seychelles, Diego di Garcia, and Port Essington, in New Holland. But supposing that this should be considered too great an expense for England, much might be done by the authorities at Mauritius, by a system of simultaneous observation during the hurricane months, at that island, Rodriguez, and Bourbon, where the French, ever ready to forward science, would no doubt heartily co-operate, or, at all events, allow others to go there for the purpose. Although storms never occur at Seychelles, or Diego di Garcia, it is very desirable that the state of the monsoon at these points should be noted during the hurricane season. An accurate knowledge of the nature, track, and extent of revolving gales, is only to be obtained by correct information regarding the state of the winds at a distance, and on every side beyond the sphere of their action.

The great practical facts to be obtained are, the course which hurricanes follow from the neighbourhood of Sumatra and Java; their extent; rate of diurnal progression, and whether this is governed by fixed laws, and, as propounded in the following pages, diminishes in velocity towards the tropic of Capricorn; and finally, the state of the barometer and weather.

A system of extended observation prolonged for a few years, or even during the hurricane seasons, if properly organized, would do more to solve these questions than all the isolated and accidental information collected by many individuals. Much valuable meteorological inquiry might be carried on at the same time, particularly with regard to the prevailing currents of air of a local kind in the vicinity of land, and the conditions of the atmosphere during the alternate changes from the S.E. trade-wind to the N.W. monsoon, south of the equator.

Of course we merely glance at this subject in the hope that, sooner or later, it may be taken up by those whose interests are more especially at stake in the inquiry. While ships and cargoes are insured, individuals are not likely to engage very warmly in the affair; but the sympathies of England as a nation ought to be extended to the preservation of the lives of a class of men to whom she is so much beholden for her wealth, her glory, and her power; and to whom she may, ere long, have to turn for that protection against foreign insult and aggression which never yet has failed her. As a military nation, she ought to feel anxious for the safe return of the thousands of her soldiers who, after a long absence from their native land, and escaping the hardships of Indian service, and the dangers of many a well-fought field, are exposed to even more imminent peril from those disastrous tempests which haunt their homeward path.

SECTION II.

GENERAL REMARKS CONNECTED WITH THE RODRIGUEZ HURRICANE OF APRIL, 1843.

It is scarcely possible to reside at Mauritius without participating in the anxiety which pervades every class of persons during the season when tempests are expected. The indications of a coming storm are as closely watched by the inhabitants of the gorgeous mansion, as by the negro in his fragile hut. Fortunately, however, the symptoms of danger are much more frequent than the realization of it.

In the beginning of April, 1843, the state of the weather and barometer, accompanying a strong gale, at Port Louis, led the more experienced inhabitants to think that the "tail of a hurricane" was passing over the island, and in a few days their predictions were confirmed by the arrival of the vessels which had experienced it. From the 12th to the 15th, the telegraph was covered with signals reporting the successive appearance of a number of disabled, almost unmanageable, and leaky vessels, covered with emblems of distress, or firing guns for help, finding it almost impossible, even in sight of their port, to work their way in. Such a fleet of wrecks from one storm had never perhaps put into Port Louis before. The monotony of colonial life, and, in particular, of that of Mauritius, was interrupted by an unusual degree of excitement, as it was coolly remarked by an idler, that "another lame duck" was signalled off the harbour.

A visit to the anchorage was sufficient to heighten this interest into a feeling of sympathy. There, a group of shattered vessels covered the bay, some without their masts, and in place of them a few spars stuck up as jury-masts, others heeling over to one side, from the shifting of their cargoes in the gale, and all having their upper works, boats, bulwarks, and everything which had been on deck, swept away, while in several, the pumps were still kept going by the weary crews. Everything, in fact, showed the terrible encounter sustained by these unfortunate ships during the late gale.

A mere perusal of the log-books of these vessels conveyed a very imperfect idea of the fearful scene which the writers had passed through. The daily routine of filling up the ship's journals with the dry details of commonplace matters, has a tendency to unfit the mind to break through formality and deal with more stirring events as they deserve.

The oral information which we received of the hurricane that had occurred off Rodriguez from the officers of the damaged vessels, was of a much more interesting character, being fraught with the exciting details of the grand and terrific scenes through which they had passed, and which seemed to have left an indelible impression on their memory. All declared that they had "never been out in such a gale before, and hoped never to be again." It is said that sailors always consider the last gale as the worst, but those who have been in a tropical hurricane, speak of it, after a long life spent at sea, as of something infinitely surpassing all other dangers of the same nature.

Having obtained copies of the logs of the several ships, an attempt was made to discover whether the storm was of a rotatory kind. Notwithstanding the discrepancies of one or two, the general result was so very satisfactory in establishing the circular direction of the wind over a space of many hundred miles, that we determined to pursue the subject a little further, for the purpose of reconciling the few inconsistencies which interfered with a complete view of the case,—and were ultimately successful. For instance, in one log, the wind was recorded to have been S.W., but the latitude and longitude of the vessel placed her in a position near five or six others, all with the wind at N.E.; it was thus obvious that something was wrong. On further inquiry, we ascertained that she was several degrees further to the west than by her reckoning, and when placed in her true position on the diagram, she was exactly among the ships with the S.W. part of the gale. Another vessel had her log washed overboard, and of course lost her reckoning. Fortunately, however, from the number of vessels involved in the storm, and their being in many instances seen by one another after it had passed them, there is no difficulty in finding out the errors of the few, by means of the general accuracy of the majority.

It is not to be wondered at that ships should be out in their dead reckoning, after having been buffeted about for many days by winds from every point of the compass, exposed to unknown currents, and wrapt in obscurity by the murky atmosphere under the dominion of the tempest: indeed, it is next to impossible that they could be altogether correct. Hence the difficulty of determining the character of a hurricane when we depend on the information received from one or two vessels only. Many of the ships in the Rodriguez storm had been nearly a week without any observation of the sun to rectify their calculations from the log. The result was, that they found themselves considerably to the westward of their reckoning after the gale was over, owing to the prevalence of a westerly current in the neighbourhood of Mauritius, caused by the trade wind.

The existence of this current at the time of the Rodriguez gale, appears to have been very opportunely proved by the shipwreck of the *Victoria*, on the reefs to the eastward of that island. This vessel went ashore on the 7th April, three days after the hurricane had passed over it, and, about a month afterwards, part of the wreck was picked up on the coast of Mauritius, 300 miles to the westward of Rodriguez. Among other articles, a trunk belonging to the captain of the *Victoria* had been found, and was lying at the police office when he and his crew were brought to Port Louis. This would indicate a current of ten miles per diem, and is well known to coasting vessels at Mauritius. We believe that Horsburgh alludes to it in his valuable directions to ships trading to India. Now we suspect, that few, if any, of the vessels involved in hurricanes off Mauritius make allowance for this set to the westward, which partly explains the reason of so many having lately gone on the reefs on the east coasts of Rodriguez and Mauritius. A vessel running west, without a sight of the sun for several days, might thus very easily be 40 or 50 miles further west than her calculations would make her, and if driving at the mercy of a tempest, without a light on board, or a compass on deck, to tell the direction of the ship's head and veering of the wind, a much greater error might be reckoned on.

It is hardly possible to expect a more favourable opportunity than that offered by the Rodriguez hurricane for studying the nature of such disturbances of the atmosphere. Having fourteen or fifteen different vessels more or less entangled in the stormy circuit, either sailing on its skirts, crossing its path, following in its wake, rushing into the very focus, or scudding round the vortex till rendered unmanageable by the fury of the sea and wind, we obtain contemporaneous information of the state of the weather at different distances from the centre, for a number of successive days, and along a track of 1500 miles. The errors of a few ships are amply compensated by the uniform results derived from such a multiplicity of observations, repeated day after day. Still we cannot but regret that the logs had not been kept more accurately and in detail, for, with the exception of one vessel, the barometric information is either very meagre or entirely wanting.

Although in possession of extracts from these logs, we obtained as much verbal, and other collateral information as we could, and many officers were frank enough to acknowledge the mistakes which had crept into their reckoning, and readily undertook to correct them. Being in the hurry of embarkation, when the ships which had been in the Rodriguez storm put into Port Louis, we took only some brief notes, as given in another place, of the state of the winds and the weather, previous to the more severe part of the gale, by which its track has been ascertained further than, in the first instance, appeared to be practicable. Unluckily, when the value of these notes was discovered, we were on our voyage to England, and had no means of getting the full details, which would have been so much more important. Still there is enough to show that the hurricane came from long. 85° or 90° E. and lat. 10° or 12° S. Some vessels may yet be found to clear up this interesting part of the subject.

In revolving tempests within the tropics, it is almost impossible to estimate the force of the wind, especially in those terrific gusts, which occur near the vortex or centre. It has been considered that 100 miles per hour, is nearly about the velocity of the wind in a hurricane; but this is very much under-rated. If we remember the effect of a railway-train when travelling at forty miles per hour in a calm day, it is not one-fifth the force of such a storm, as would tear the well-stayed masts out of a ship. It has been said, that what are called rectilinear gales in temperate regions of the globe, are equally severe as those of a rotatory kind within the torrid zone. This is very doubtful, and all who have experienced a real hurricane do not hesitate for a moment to deny it. We have been in November gales off Newfoundland, in the Atlantic, and such a severe gale off the Cape of Good Hope, that although within eight miles of a lee shore, it was impossible to show a stitch of canvass, and yet we think they did not approach to the violence of a tropical storm.

The state of the weather perhaps in some degree heightens the effect produced by a hurricane, for it seems as if the very heavens were resting on the ocean, and the thick and gloomy atmosphere almost hides the raging elements. The unceasing rain descends in torrents, and mixing with the up-borne spray, driven along by the fury of the tempest, realizes the idea of seas contending with skies. The noise of the wind and waves shuts out every other sound, and sails are blown out of the bolt ropes, and masts carried away without being heard. Imagine a tumultuous sea breaking on board a vessel without masts, her crew up to the waist in water while working at the pumps, and the night closing in without the means of having light or fire, during the long and dreary hours of darkness, and some faint idea may be entertained of the situation of the vessels in the Rodriguez storm. On the night of the 7th of April, thunder and lightning set in, the vivid flashes from time to time, disclosing to the wretched crews the scene which surrounded their almost foundering craft in all its fearful reality, yet even this was perhaps comparative comfort, to the awful obscurity which succeeded.

Around the *Robin Gray*, this display of electric fluid was almost continuous for several hours. It seemed as if she was the very focus of its attraction, the masts and rigging were enveloped in a lurid glare, and the peals of thunder, drowning every other noise, conveyed the idea of the vessel exploding. It is the sea, however, which is most to be dreaded in rotating gales. It is described as having been a "tremendous, cross, confused, outrageous sea," raised in pyramidal heaps by the wind from every point of the compass, and has been compared to the surf breaking on a reef of rocks. In fact it was "such a sea as gave a ship no chance." Near the centre of the hurricane a ship is always unmanageable, even if she has not lost masts or rudder; "the lulls and terrific gusts," which follow one another in quick succession, are alone sufficient for this; but when we take into consideration the fierce conflict of raging waters, it is only wonderful how a vessel can live through such an encounter. In this situation ships lose their buoyancy, and lie like a rock, presenting a fixed resistance to the waves which continually burst over them. Many of the deep loaded ships in the Rodriguez storm, when thus exposed, had four or five feet water in their holds, and seemed to be fast settling down into the dark abyss beneath them, with the water entering at their opening seams, and while one sea was curling over the bows, another was meeting it from the poop, and perhaps a third expending its strength on the beam. It was only by almost superhuman exertions at the pumps, that the vessels were kept afloat. It requires no ordinarily built ship to withstand the force of the waves and wind near the vortex of a hurricane, and all will do well to shun the danger in time, by not running too far into a position where they may soon lose the power of scudding out of danger, or lying to under command, as in the long and true, although mountain swell of straight gales, where a vessel rises to it with comparative safety and regularity.

There is something curious and almost inexplicable in the different kinds of injury sustained by the ships in the Rodriguez gale. Some suffered chiefly in their masts, spars, and rigging, others in their hulls and upperworks. The *Robin Gray*, although as much engaged in the storm as any other, had none of her masts carried away, and the *Katharine Stewart Forbes* had boats, bulwark and everything on deck swept off, and was "burying herself in the seas," yet she had her royal yards across the whole time, without losing an important spar, although the close-reefed topsails were blown clean out of the bolt ropes. The explanation which we received was, that the light ships roll and strain, so as to chafe their rigging, and carry away their masts, while the heavy laden lie like logs, and are exposed to the fury of the "cross-sea." Some say, that in consequence of having their lofty masts up, they lie over more steadily to the wind, and therefore suffer less from rolling. The subject is interesting, but one with which we are not conversant.

It is not the object of this paper to enter into an account of the toils and suffering, or passions and feelings, of the many human beings endangered in the Rodriguez storm. It chanced that on board the little fleet of vessels drifting about at the mercy of the tempest, there were many hundreds of veteran soldiers, with laurels recently gathered on the fields of India, who, after an absence of twenty years, were thus, in returning to their home, almost doomed to a watery grave. Here too, many bands of Hindoo labourers for the Mauritius, tempted by the love of gain, had broken through the prejudices of their caste, and for the first time embarked on the ocean, and soon discovered its uncertain nature. But even to the crews, inured to hardship and danger, the occasion was a trying one, and demanding that intrepidity, patient endurance, and unflinching exertion, which pre-eminently distinguish the British sailor "in the battle or the breeze."

But of all the duties which devolve on mariners, there are none more harassing than that of incessant labour at the pumps, when failing physical strength must be stimulated by moral courage, and where rest is fatal to the leaky fabric with which their lives are linked. In fine weather, and smooth water, it is far from pleasant to find that the utmost exertion can hardly check the entrance of water into the vessel that bears us on its bosom. What, then, must it be in the midst of a hurricane, to know that the sea is rapidly rushing in, while the interminable clank of the pump steals on the ear with low, but far more fearful meaning than the loudest howling of the tempest, the crash of falling masts, or tremor of the hull writhing beneath the fury of the waves. A ship may be shorn of her spars; and boats, bulwarks, and everything that can be laid hold of may be swept away, but while she is tight below all goes well, and work goes cheerfully on. If, however, the leak is gaining, and further toil seems vain, it requires a firmness and fitness for command of no common kind, to support the flagging strength and spirits of the crews. Many of the vessels in the Rodriguez gale were kept afloat, solely from the number of persons on board to furnish reliefs at the pumps, during the continuance of the hurricane.

But we are fast straying from the object which we have in view, that of seeking for the means of avoiding, instead of attempting to depict, the horrors and suffering incident to a tropical storm.

SECTION III.

ON THE RODRIGUEZ HURRICANE OF APRIL, 1843.

In tracing out the Rodriguez storm, we repudiate the conjectural, and confine ourselves, as strictly as possible, to the simple facts as they come before us—merely arranging them in what seems to be their relative positions. The objects in view are, to discover its track; daily rate of progression; rotatory character, and the direction of its revolution; the extent of its influence; and the state of the weather, wind, and sea, at different points from the centre. Thus, we have disposed the information gathered from the log-books of vessels in and near the storm, and other sources, in such order as to approach to simultaneous observations.

The period fixed upon for this purpose is that of noon in each day, and nautical time is adopted as convenient. In stating the latitude and longitude of the respective vessels, it is always meant to denote their position at this period of the particular day under consideration. In some of the ships' journals, the wind is not recorded for six or eight hours before, we therefore imagined that it would be nearer the truth to consider its proper direction as noted two hours after noon, although in the observations belonging to the subsequent day; and as this is the usual time at which the log-books are made up, it is more likely that the writers were accurate in their statements. But, generally speaking, on board of merchant vessels, the wind, after shifting to a new direction, prevails for an hour or two before it is mentioned in the journal. In other cases, we also find out by the change in the ship's course, if she is close hauled, that a variation in the wind must have taken place, although without being noticed. These, however, are grave obstacles in the way of arriving at great exactitude, and are only overcome by the variety of observations correcting each other.

With the view of illustrating the subject, we have projected a series of diagrams from No. 1 to 12, exhibiting the direction of the wind at the different points where the vessels chanced to be, on the day to which each refers. Although we have drawn up a diagram for every day on which the traces of the storm were evident, it is intended only to publish a select number, but on the general map the whole are noted down in their relative positions.

Having satisfied ourselves of the exact latitude and longitude of the respective vessels at noon, their places are indicated on the diagram by a number, which is arbitrarily employed to distinguish each in our list, and an arrow, showing the true direction of the wind, is pencilled out as near it as possible. It will be seen, however, that a point or two of variation of the wind, in one way or another, cannot, in any material degree, affect the general result—nay, even the error of thirty or forty miles in the situation of the vessels, unless when near the centre of the storm, would not negative inferences collected from the *whole*. From the veering of the wind, the state of the weather, &c., obtained by examining the log-books, on the particular day, and the general direction of the arrows, we fixed on a probable point as being the focus of the hurricane, and by means of a compass drew concentric lines around it, which embraced all the arrows. Having accomplished this for each day, the centres were noted down on a general chart, and the result is such as we have given. It is needless to say how gratifying it was to find that the foci occupied a re-

A TABLE *of the Numbers arbitrarily attached to particular Vessels, for the convenience of finding their position on the Diagrams illustrative of the Rodriguez Hurricane of April,* 1843.

1. THE MARGARET.
2. THE ROBIN GRAY.
3. ARGO.
4. RAMBLER.
5. BLANCHE.
6. BROXBOURNBURY.
7. SEA QUEEN.
8. VELORE.
9. KATHERINE STEWART FORBES.
10. WAVERLEY.
11. PARLAND.
12. WELLINGTON.
13. FRAMJEE COWAJEE.
14. SURAT MERCHANT.
15. GAZELLE.

[*To face page* 21.]

gular curving line, extending from latitude 10° S. to the southern tropic, and were separated from one another by intermediate distances gradually diminishing in length as the track diverged from the equator. We were in a great measure prepared to expect the former result, but certainly not the latter. Whether this is common to all other storms may be more properly examined hereafter. At present we shall proceed to the dry and somewhat tedious details of the hurricane under immediate consideration, but as the subject is of deep interest, as affecting the safety of our fellow creatures and the prosperity of our commerce, it is scarcely necessary to apologize for minuteness and necessary repetition.

The vessels whose log-books we have inspected, appear to have come in collision with the storm in two groups, one, composed of the *Katherine Stewart Forbes*, *Waverley*, *Argo*, and *Rambler*, coming from the Straits of Sunda, from the eastward; the other, formed by the *Blanche*, *Sea Queen*, *Robin Gray*, *Broxbournbury*, &c., approached from the northward and westward.*

The *Katherine Stewart Forbes*, left the heads of Java about the 15th March, with W.N.W. and N.E. winds, and no bad weather. In latitude 6° S. she fell in with the S.E. trade, and with fine weather continued her voyage to the westward, occasionally experiencing remote indications of the hurricane before getting into it to the southward of

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* A Table of the numbers attached to particular ships for the purpose of referring to the diagrams illustrative of the Rodriguez storm.

No. 1.	Margaret.	No. 9.	Katherine Stewart Forbes.
2.	Robin Gray.	10.	Waverley.
3.	Argo.	11.	Parland.
4.	Rambler.	12.	Wellington.
5.	Blanche.	13.	Framjee Cowajee.
6.	Broxbournbury.	14.	Surat Merchant.
7.	Sea Queen.	15.	Gazelle.
8.	Velore.		

Rodriguez. The other ships from the Straits of Sunda met with nothing remarkable till they reached longitude 65° E. Hence we may safely infer that the hurricane did not originate to the eastward of Java.

The first indications of its existence may be referred to the 23rd or 24th of March, when, in lat. 7° 28′ S., long. 79° 10′ E., the *Broxbournbury* had the wind at W.S.W. to W.N.W. in "heavy squalls," with "incessant rain," while the *Katherine Stewart Forbes* in lat. 10° 52′ S., long. 97° 27′ E., had the wind at E. by S. squally, with heavy rain.

On the 25th of March. the *Katherine Stewart Forbes,* in lat. 11° 59′ S., long. 95° 52′ E., had a strong *east* wind. In lat. 7° 58′ S., long. 82° E., the *Sea Queen* experienced a *long swell from the southward,* with the wind at S. by W. Three degrees farther to the west, and nearly in the same latitude, the ship *Broxbournbury* had the same wind and weather,—"dark and gloomy."

On the 26th of March, in lat. 13° S., long. 92° E., the *Katherine Stewart Forbes* had a fine E.S.E. wind. At the same time the *Broxbournbury,* moving to the southward, had the wind veering from S.W. to S.E., and blowing fresh, accompanied by "squalls," obliging her to carry two reefs in the topsails, in lat. 8° 52′ S., long. 79° 10′ E. The *Sea Queen,* in long. 81° S., lat. 8° 49′ E., had the wind changing in the same manner; the weather "gloomy," attended by heavy squalls and rain, with a high southerly sea.

The centre of the gale was most probably about lat. 11° 30′ S., long. 90° E.

On the 27th of March, the *Robin Gray*, in lat. 10° 30′ S., long. 77° 30′ E., met in with a strong *south-west swell,* but had the wind at S.E. The *Sea Queen*, in lat. 11° 8′ S., long. 80° 47′ E., had the wind at S. by E. squally and wet. The *Katherine Stewart Forbes,* in lat. 14° 48′ S., long. 89° 20′ E., encountered "*a heavy swell running to the westward,*" and the wind S.E.

On this day the centre must have been about lat. 12° S., long. 86° E.

28*th March.*—DIAGRAM, No. 1.

The *Katherine Stewart Forbes,* in lat. 15° 44′ S., long. 86° 25′ E., had a strong squally trade from E. to S.E., and a heavy swell, as on the previous day.

In lat. 12° 22′ S., long. 80° 41′ E., the *Framjee Cowajee* had "heavy gales" from the S.S.E., "*a cross confused sea,*" constant rain, and heavy squalls; was under double or treble reefed topsails.

The *Sea Queen,* almost in the same latitude, but in long. 78° E., had nearly the same kind of weather, but not quite so severe, although "squally and gloomy." Near her was the *Blanche,* also with the wind S.S.E., similar weather, and a *long heavy swell.*

The *Robin Gray,* in lat. 12° 10′ S., long. 75° E., found the wind at S. by E., accompanied by a "*cross turbulent sea.*"

The *Broxbournbury,* in lat. 12° 22′, long. 76° 7′, had a fresh gale at S.S.E., and was under double-reefed topsails. Heavy squalls, much lightning to the westward, and the appearance of the weather so very threatening that the royal yards were sent down on deck.

To the westward of all, the *Margaret,* in lat. 9° 37′ S., long. 73° 41′ E., had light variable winds, but unsettled weather, and was between the monsoon and the trade wind, which she met next day.

The centre of the storm, now gathering strength and coming up with the above ships, must have been about lat. 12° 30′ S. long. 81° 40′ E.

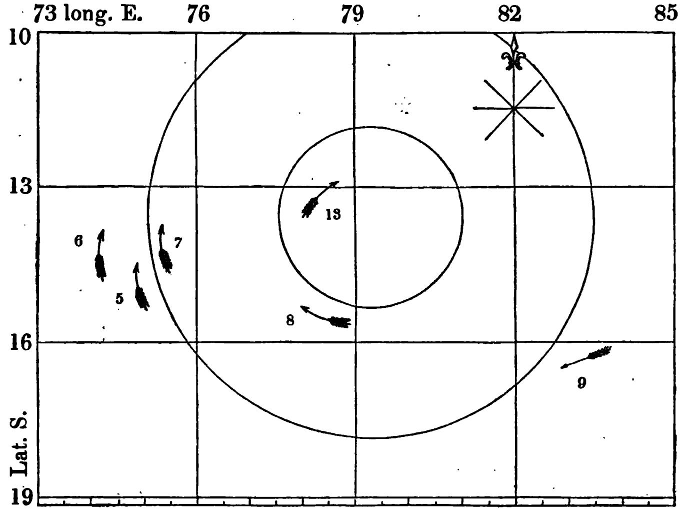
29*th March.*—DIAGRAM, No. 2.

We find on this day that the *Katherine Stewart Forbes,* in lat. 16° 20′ S., and long. 83° 18′ E., had rather severe weather, "carried away some sails," was "shipping seas over all," with a gale at E. by N. accompanied by *heavy rain* and *sharp squalls.* She was on the east side of a vast whirlwind.

The *Velore,* in lat. 15° 20′ S., long. 76° 58′ E., was under double-reefed topsails with a gale at E.S.E.

DIAGRAM 2.

THE RODRIGUEZ STORM ON THE 29TH MARCH, 1843.



In lat. 13° 20′ S., long. 73° E., the *Robin Gray* had a southerly breeze, and swell from the same quarter, with cloudy weather.

The *Margaret,* in lat. 10° 46′ S., long. 70° 23′ E., had the wind at south attended by "dark threatening weather, heavy rain, and sudden gusts."

The *Blanche,* about lat. 14° 51′ S., long. 74° 46′ E., had "a heavy sea from the eastward, was also shipping seas," with the gale at S.S.E, and two reefs in her topsails. Not far from her, the *Broxbournbury* and *Sea Queen* had the same wind and weather.

The *Framjee Cowajee* had the wind at S.W., with "heavy squalls, constant rain," and thick cloudy weather, in lat. 13° 20′ S., long. 78° 20′ E. This vessel appears to have been near the focus, as on this day the wind veered from S.E. to S.W., and continued the next twenty-four hours to go round the compass by west to N.W.

Here we have a vast circle, with the wind, at east, gradually deflecting from the *Katherine Stewart Forbes's* position, to the south, near the *Robin Gray;* and, about the centre, as far as S.W.; while the westerly monsoon turning to N.W. would complete it.

We assume that the focus was not far from the *Framjee Cowajee.*

30th March.

It may be as well to recall to the remembrance of our readers, that all the vessels to whose log-books we are constantly referring for extracts, were sailing to the westward or S.W., some to the Mauritius, and others homeward bound. They were consequently in front of the hurricane, and moving along the path by which it will be subsequently seen to have come up with them.

On this day, the centre of the storm seems to have been about lat. 14° 10′ S., long. 75° E. Its character, as a rotatory gale, may fairly be demonstrated by the positions of the following ships, and the weather experienced by them.

The *Framjee Cowajee*, in the course of the twenty-four hours, dropped behind the vortex, and at noon was in lat. 14° 18′ S., long. 78° 20′ E. The wind at N.W. by N., with heavy squalls, but gradually moderating.

On the opposite side, the *Robin Gray,* in lat. 14° S., long. 70° E., had a strong wind at south, veering to west, accompanied by a heavy swell.

In lat. 17° S., long. 81° E., the *Katherine Stewart Forbes* had the wind at east by north. "Unsteady trades, strong winds, a heavy sea, *constant rain.*" Split the main-royal and fore-topmast staysail.

Towards the centre of the circle indicated by the above ships, we find the *Sea Queen* and *Blanche* beside one another, in lat. 15° 10′ S., long. 73° 10′ E., with the storm blowing from south to S.S.E., the weather squally, gloomy, and raining heavily. The one with two, and the other with three reefs in their topsails. A little more to the S.W., the *Broxbournbury* was similarly situated, and making such heavy weather that her top-gallant masts and yards were struck.

We thus find the tempest gradually overtaking the three last-named ships, although they were scudding before it at the rate of ten miles an hour. It is exceedingly to be regretted, that no information regarding the state of the barometer on board of any of these vessels, during this early stage of the gale, could be obtained.

31*st March.*—DIAGRAM, No. 3.

The vortex, rapidly advancing about W.S.W., had reached lat. 15° 10′ S., long. 72° 10′ E., about noon of the 31st, and was not far from several of the ships scudding before it.

The *Sea Queen*, in lat. 15° 37′ S. acct. long. 71° 20′ E. acct. and not far from her, the *Blanche*, also had the wind at S.S.E., blowing hard, with "squalls and heavy rain;" the weather thick and gloomy, and the sea high. The former had two and the latter three reefs in their topsails.

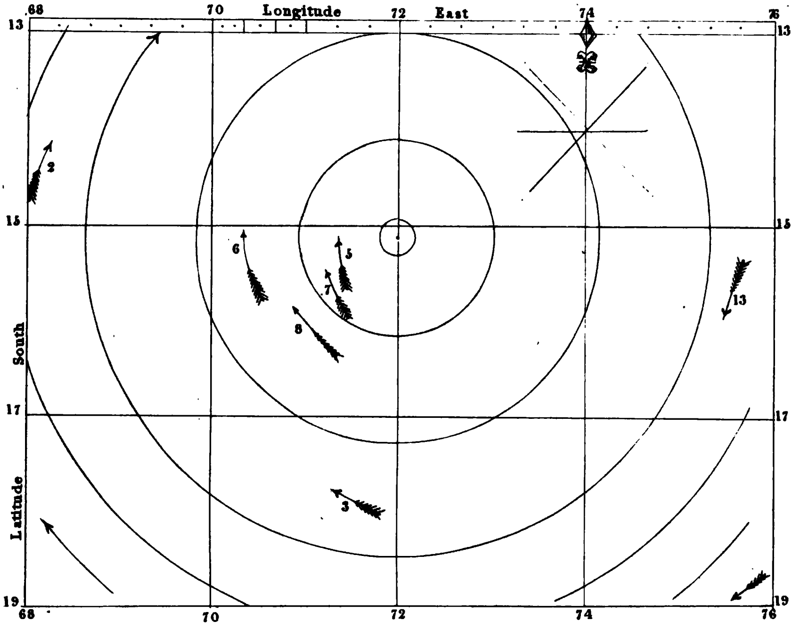
The *Broxbournbury*, nearly in the same latitude, but in long. 70° 24′ E., experienced a similar description of wind and weather, and was running to the westward under three reefed topsails. "The ship straining heavily" from the violence of the squalls and sea.

More remote from the centre, but within the influence

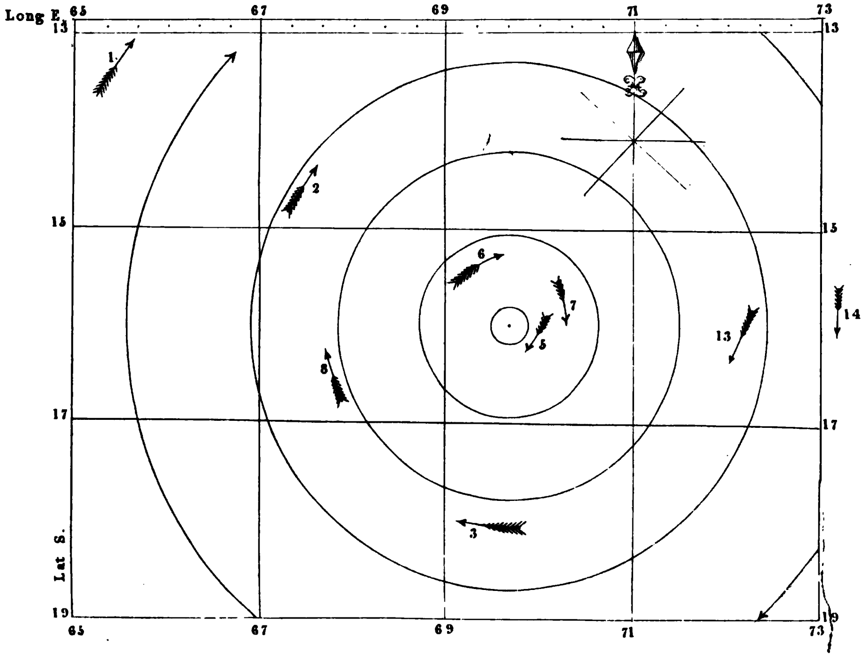
PLATE, II.

DIAGRAMS III AND IV.

No III. POSITION OF THE RODRIGUEZ STORM ON 31st MARCH, 1843.



No IV. POSITION OF THE SAME STORM ON THE 1st APRIL 1843.



of the tempest, and nearly in its wake, we find the *Framjee Cowajee*, in lat. 15° 24′ S., long. 75° 41′ E., with the wind at N.E. after having veered from N.W. by N.

At the same moment, the *Robin Gray*, at the reverse side of the vast whirlwind, had the gale at S.S.W. in lat. 14° 25′ S., long. 68° E.; and the *Margaret*, in lat. 12° S., long. 65° E., had a light breeze from south.

The *Katherine Stewart Forbes*, in lat. 17° 45′ S., long. 78° 39′ E., had a strong east wind, accompanied by a heavy sea and "incessant rain;" while the *Argo*, in nearly the same latitude, but in long. 71° 48′ E., had the wind at S.E. blowing strong, with a heavy swell from the southward.

With regard to the two last vessels, we may here observe, that the *Argo's* course being due west to Mauritius, she ran into the storm on the 4th of April, while the *Katherine Stewart Forbes*, steering more to the southward, or nearly S.W., did not encounter its violence till the 8th of April.

The *Velore*, in lat. 16° 15′ S., long. 71° 12′ E., had a storm at S.E., and was under close-reefed topsails.

1*st April.*—DIAGRAM, No. 4.

The hurricane was approaching towards the island of Rodriguez, and curving more to the southward. We merely notice this fact, without pretending to say whether it did so in accordance with the general laws which apparently govern its motions; from the influence of the island; or some other unknown cause of disturbance. The focus seems to have been about lat. 16° S., long. 69° 40′ E., and, in the course of the twenty-four hours, had passed almost directly over the *Sea Queen*. Although the vortical character of the storm is sufficiently evident on this day, and its violence very great, it appears to have been inferior to that exhibited after it passed to the south of Rodriguez. The ships certainly did not sustain any serious damage. It may be, however, that from the more rapid progress of the vortex at this early stage, they were exposed to its fury for a much shorter time; and, from the same cause, there was less time for the sea to be raised to that destructive turbulence to which it subsequently attained.

The relative positions of the vessels at noon are as follows:—

The *Sea Queen*, during the twenty-four hours, had a heavy storm—the wind in furious gusts veering from S.S.E. to S.W., W., N.W., and by noon was at N. when in about lat. 15° 45′ S., long. 70° 10′ E. The weather was "very threatening," thick, and "raining incessantly," accompanied by much thunder and lightning. The sea must have been very heavy, as she is described to have been "rolling and labouring heavily."

The *Broxbournbury* was in or near the edge of the calm which always exists in the middle of a storm, in latitude 15° 19′ S., long. 69° 25′ E., with the wind at S.W. by W., after having veered from S. to S.S.W. During the twenty-four hours it blew with great fury in *squalls*, attended by *thick* weather and constant rain. She had the fore-topsail stowed, and was under close-reefed main-topsail. At 6 A.M. it suddenly moderated, but the weather looked so portentous, accompanied by lightning "all round," that some of the upper spars were sent on deck, and all the necessary precautions against a hurricane were taken. Next day's log records "fresh gales;" so that it appears a calm, or light winds, of six hours' duration supervened. The vessel was in fact dropping round the N.W. side of the focus, and kept somewhat longer in it by her course to the westward and southward, as the winds permitted.

It is interesting to find the *Blanche*, not sixty miles from the *Broxbournbury*, but on the opposite side of the vortex, and perhaps at one time in it, having the wind veering in the opposite direction—from S. to S.E., and ending at N.E. about noon, when in lat. 15° 58′ S., long. 70° E. She had the same kind of weather, "heavy rain, squalls," and a "heavy gale," attended by a high sea. At daylight had "*better weather,*" and let out all reefs; but by 11 A.M. she had the storm strong from N.E.

The focus must have passed over the *Sea Queen,* and was between the *Blanche* and *Broxbournbury;* both experiencing that cessation of the tempest which invariably characterizes the Mauritius gales. It will be found, however, that, at a distance from, and around the space embraced by these three vessels, the wind was blowing with great force and steadiness.

The *Framjee Cowajee,* in lat. 16° 7′ S., long. 72° 15′ E., had it at N.E. by N., with heavy squalls, and was under reefed topsails.

The *Surat Merchant,* in lat. 15° 38′ S., long. 74° E., had a *north* wind in considerable force, with rain and "heavy squalls."

In lat. 18° 28′ S., long. 75° 59′ E., the *Katherine Stewart Forbes* had a strong *east* wind and rainy weather.

The *Velore,* in lat. 18° 48′ S., long. 69° 33′ E. (we suspect her true position to have been somewhat farther south), experienced the gale at S.S.E. to S.E., "with dirty weather, thunder and lightning, and heavy rain." She was under three-reefed topsails, running S.W.

The *Robin Gray,* in lat. 14° 30′ S., long. 67° 20′ E., seems to have had similar weather, but a S.W. storm with such violence that by noon she was under close-reefed topsails: a heavy swell from the southward, and the rain falling in torrents.

The *Margaret,* more to the north-west of the storm's centre, had the wind also at S.W., with heavy squalls, rain, and a head sea (S.E.), in lat. 13° 2′ S., long. 65° 30′ E.

The *Argo,* in lat. 18° 1′ S., long. 69° 12′ E., had strong gales, a heavy sea from the south, and the wind at E.S.E. She was running westward with two reefs in the topsails.

2nd April.—Diagram, No. 5.

On this day the vortex advanced as far as lat. 17° 10′ S., long. 67° 20′ E.; and around it the several vessels from which we have our information were distributed as follows:—

The *Margaret*, in lat. 14° 32′ S., long. 65° 56′ E., had the wind at W.S.W., with "threatening-looking weather," vivid lightning, heavy squalls, seas breaking on board, and the ship pitching heavily.

The *Robin Gray*, in latitude 15° 45′ S., long. 67° 20′ E., had a severe gale blowing from *west*, with "a high cross sea," constant rain, heavy squalls, the vessel shipping a great deal of water, and was scudding south by west, under close-reefed main-topsail and reefed foresail. By this course she was edging away to the south-east of the path of the storm.

In lat. 16° 30′ S., long. 68° 20′ E., we find the *Broxbournbury* with the wind from S.W. by W., changing to N.W., and finally about N.N.W. at noon. It is described in her log-book as being "fresh gales," with a heavy swell from S.S.W., "causing the ship to strain and labour greatly."

In the wake of the storm, about lat. 16° 50′ S., long. 69° 9′ E., the *Framjee Cowajee* had a *north-north-east* breeze, rather squally, "the weather threatening," and she was compelled to keep under three-reefed topsails.

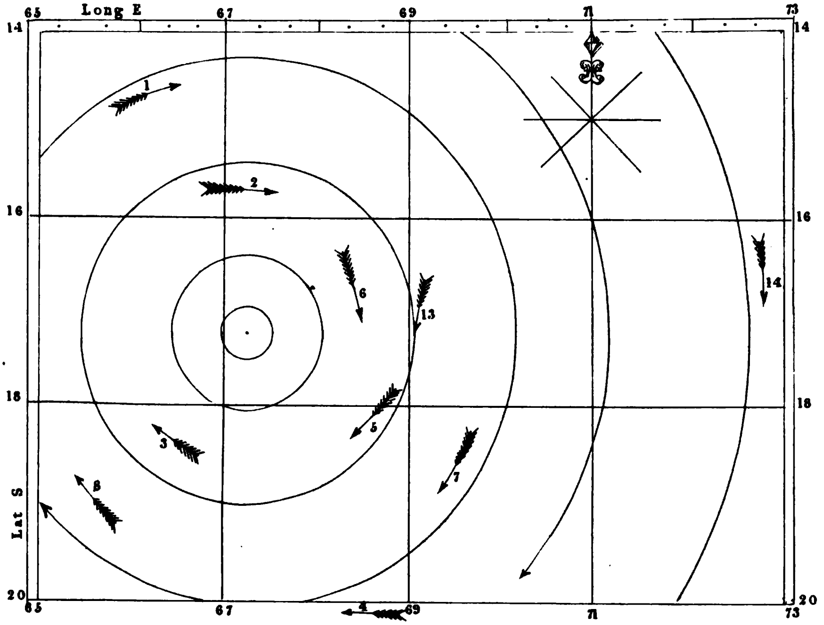
On the south-east side of it, the *Blanche* was in lat. 17° 59′ S., long. 68° 50′ E., and had the wind from *north-east*, with a heavy sea; but she was diverging somewhat to the eastward of the central path.

The *Sea Queen*, in lat. 18° 42′ S., long. 69° 25′ E., with the gale from N.N.E. to N.E., had similar weather to the *Blanche*. She appears to have been sailing parallel to the course of the storm, on its eastern border, and rather advancing ahead of it.

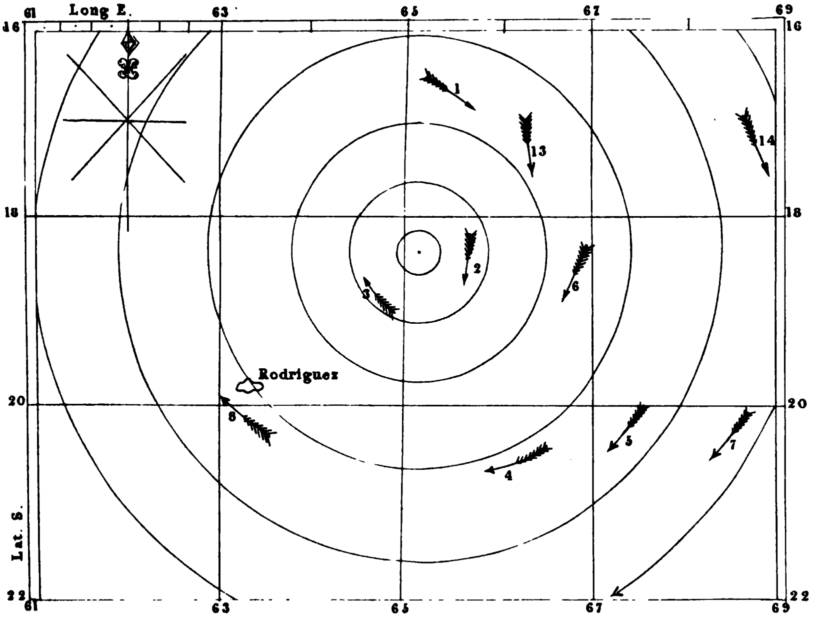
PLATE, III.

DIAGRAMS V AND VI

N°. V. POSITION OF THE RODRIGUEZ STORM ON THE 2nd APRIL 1843



N°. VI. POSITION OF THE RODRIGUEZ STORM ON THE 3rd APRIL 1843.



The *Rambler*, in lat. 20° 15′ S., long. 68° E., had a squally gale at *east*, accompanied by a "cross sea and heavy rain."

The *Velore*, farther west, in lat. 19° S., long. 65° 47′ E., with a *south-east* wind, had squally, wild, and unsettled weather.

The *Argo*, in front of and on the path of the storm, had the wind at E.S.E., blowing a severe gale, "hard squalls," and a cross heavy sea from the southward; and was under double-reefed topsails at noon, when in lat. 18° 17′ S., long. 66° 16′ E. In a few hours after, on the subsequent day (nautical time), she was under "bare poles."

On her way to Mauritius, the *Gazelle*, in lat. 27° 55′ S. ob., long. 58° 45′ E., had a strong S.S.E. wind.

The *Surat Merchant*, in lat. 16° 28′ S., long. 72° 41′ E., had a breeze at north.

3rd April.—DIAGRAM, No. 6.

We find the vortex of the hurricane moving towards the island of Rodriguez, and at noon was about lat. 18° 20′ S., long. 65° 10′ E. The violence of the wind, apparently, much augmented. The log-books furnish us with a repetition of the same details as on the previous days, which we must collate as briefly as possible.

The *Robin Gray*, had fallen into the northern and after part of the storm on the 2nd and 3rd of April, but, in consequence of its daily rate of progression having begun to diminish in a considerable degree, she was enabled to come up with it on this day, and, about noon, was scudding with the wind at N. to N.N.E., lat. 18° 20′ S., long. 65° 30′ E. acc^{t}. She was under close-reefed main-topsail and reefed foresail, and steering a course parallel to that of the hurricane. The weather dark and gloomy, the rain incessant, and pouring down "in torrents," and as usual squally, and a high cross sea running. She was most probably a little more to the southward than according to her dead reckoning.

The *Margaret,* with a westerly wind, was running into the very centre of the tempest, and by making 120 miles of southing, she left "moderate weather" to encounter a dark lowering sky," and increasing gale, with lightning from the west; the wind gradually veering to N.W. by W., lat. 16° 38′ S., long. 65° 30′ E.

The *Argo,* during the twenty-four hours, had been steering due west, with a breeze veering from E.S.E. to S.E., and at noon, was in lat. 18° 52′ S., long. 64° 33′ E. She was lying exactly in front of the approaching vortex, and suffering from the storm in a severe degree. Her sails were all stowed, "the sea making a complete breach over her," and the weather such as is usually experienced in hurricanes. — She was kept before the gale under bare poles.

Hanging on the skirts of the storm, and almost in its wake, the *Framjee Cowajee,* in lat. 17° 18′ S., long. 66° 18′ E., had squally unsettled weather, with a northerly wind. A heavy "*cross sea*" from the westward, and the " vessel pitching bows under."

The *Surat Merchant,* in 17° 22′ S., long. 70° 37′ E., had a N.N.W. wind, unsettled weather, " occasionally fine," and a " *confused swell.*"

The *Broxbournbury,* about 100 miles to the eastward of the focus, was steering S.W., parallel to the course of the storm, and had it changing from N.N.W. to N.E. At noon in lat. 18° 31′ S., long. 66° 57′ E.

The *Blanche,* on this day had been steering so much to the south, and diverged so far from the centre of the gale, that, although she had a "fresh breeze" from N.E. she was carrying studding sails. Lat. 20° 14′ S., long. 67° 25′ E.

The *Rambler* had an east wind and "turbulent sea" in lat. 20° 30′ S., long. 66° 3′ E. She had been scudding to the westward, and consequently approaching the path of the hurricane. The weather was thick and raining steadily. She was under double-reefed topsails and "rolling gunwale under."

The *Velore*, nearly in front of it, and in lat. 20° S., long. 63° 10′ E., had the storm at E. by S. The sea was "heavy and cross," and "constantly breaking on board." An increasing gale. She was under close-reefed topsails.

At a distance from the storm, the *Gazelle* had much rain and a squally breeze at S. by E. Lat. 24° 46′ S., long. 60° E. Split her mainsail on this day.

The *Katherine Stewart Forbes*, in lat. 19° 13′ S., long. 72° 5′ E., had the wind at E. by N., fine weather, and "beautiful starlight nights."

At Mauritius, the wind was south, freshening, "cool and fine." Barometer fell to 29.90.

The Island of Rodriguez, 300 miles due east from Mauritius, was exposed to all the devastating fury of the hurricane on this day. Buildings were thrown down, and huge trees torn up by the roots, while the rain fell in torrents. The wind at E.S.E. to S.E.

4th *April*.—DIAGRAM, No. 7.

In the course of this day the centre of the storm passed over Rodriguez, with the same destructive consequences as on the 3rd April. At noon, the focus must have been about lat. 19° 50′ S., long. 63° 10′ E.

Up to this period we find that this vast whirlwind had been travelling with such velocity as to come up with the vessels, and pass by or over them. In future it will be seen that its diurnal progress is so much curtailed, that many of the ships again encounter its increasing violence, by overtaking and running into it. Some even got so far ahead of the vortex, as to cross its track before the most dangerous part could reach them.

The facts in our possession enable us to discover the extent of the circle, the relative force of the wind, and the state of the weather, &c., for the distance of nearly 300 miles on almost every side of the focus.

At Mauritius it blew a strong breeze from S.S.W., and the barometer was down to 29.80.,—while the *Gazelle* in lat. 22° S., long. 56° 26′ E., had a squally and wet gale from south, and was under double-reefed topsails.

To the eastward of the storm, the *Katherine Stewart Forbes,* in lat. 20° 21′ S., long. 70° E., had "steady trades" at E.N.E.

On its north-eastern limits, or after part, the *Surat Merchant,* in lat. 17° 57′ S., long. 68° E., had fresh breezes N.N.E., and a "confused sea;" and the *Parland,* in long. 78° E. had fine weather, almost at the very spot, where, five days before, vessels were in a heavy gale, with three reefs in their topsails, scudding before it.

Within a few miles of the centre of the storm, we have the *Velore* in lat. 19° 27′ S., long. 62° 36′ E. During the night "the gale increased to a perfect hurricane, blowing the sails from the yards." A heavy cross sea running, caused the vessel to labour heavily, and ship a great deal of water. It rained all the time, and the wind came in fierce squalls, almost tearing the masts out of her. She was hove-to during the greater part of the twenty-four hours, and had the wind veering from E. by S. to S.E., South, S.W., and it was at W.S.W. about noon. The position of this vessel is particularly interesting on this occasion, as she was not far from Rodriguez, which she sighted next day, and also on account of the observations made on the state of the barometer every two hours, apparently noted with great care and regularity, and to which we shall advert in another place.*

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* On the Island of Rodriguez, the hurricane was raging with great fury both on this and the previous day, so much so that, on the 7th April, when the Commander of the *Victoria* landed on it, the

The *Argo*, at the commencement of the twenty-four hours, appears to have been near the calm or centre of the storm, as it was so moderate that she let out some reefs. But by 6 P.M. the gale was renewed, with every appearance of a hurricane. The squalls were hard, accompanied by rain, and a very heavy sea. The vessel was kept away before the gale under reefed foresail, and ran almost round a circle with the wind veering from S.E. to S.W., West, W.N.W., N.W. North, and at noon was about N.N.E. in lat. 20° 30′ S., long. 64° 36′ E. The "ship making a great deal of water, and the sea constantly breaking on board."

The *Robin Gray* seems to have been scudding S.W. by W., the whole day, and was rather getting in advance of the storm. At noon in lat. 20° 30′ S., long. 63° 20′ E., she had the wind about N.E., and was under close-reefed topsails.

In the course of this day, the *Margaret* also came up with, and rather passed to the eastward of, the vortex. She had the gale changing from N.W. by N. to N.N.E. At noon her latitude was 19° 54′ S., long. 64° 22′ E. The weather very bad, squally and "raining incessantly." A heavy sea running, and the vessel labouring and pitching very much. She was under close-reefed topsails scudding S.W. by S. at the rate of 9 or 10 miles an hour.

The *Rambler*, with the storm blowing from E.N.E., was steering due west under "bare poles," rolling "gunwales under," and about noon was in lat. 20° 51′ S., long. 63° 16′ E.

The *Broxbournbury* was running S.W., and from moderate breezes she plunged into the S.E. side of the storm, and by noon was under three reefs in her topsails. The "ship rolling heavily and taking much water on board." The weather such as we have so often described.

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whole face of the country presented a scene of desolation. Every trace of verdure had disappeared, and the leafless trees and prostrate buildings bore ample evidence of the stength of the tempest.

At noon her lat. 20° 42′ S., long. 64° 50′ E., and the wind was at N.E.

At the beginning of the twenty-four hours, the *Sea Queen* had been well to the eastward of the gale, but by steering W. by S. she rapidly neared its path, and found the wind proportionally increasing in violence, while the weather, from "being moderate and fine," became "thick and hazy" by noon. She found the sea "cross and heavy," and was rolling and pitching a great deal. At noon, in lat. 21° 20′ S., long. 65° 30′ E., she had the wind at E.N.E.

The *Blanche* was not far from the last vessel, but her course being a point or two more to the southward, she did not approximate so closely to the storm, and only found it necessary to take in her studding-sails; however, she seems to have had a heavy sea, rain, and a fresh breeze at E.N.E., in lat. 21° 59′ S., long. 65° 28′ E.

The *Framjee Cowajee*, in lat. 18° 8′ S., long. 64° 10′ E., had a strong gale at N.N.W. The weather cloudy and gloomy, accompanied by "a continued succession of squalls and small rain." A cross confused sea running.

5th April.—DIAGRAM, No. 8.

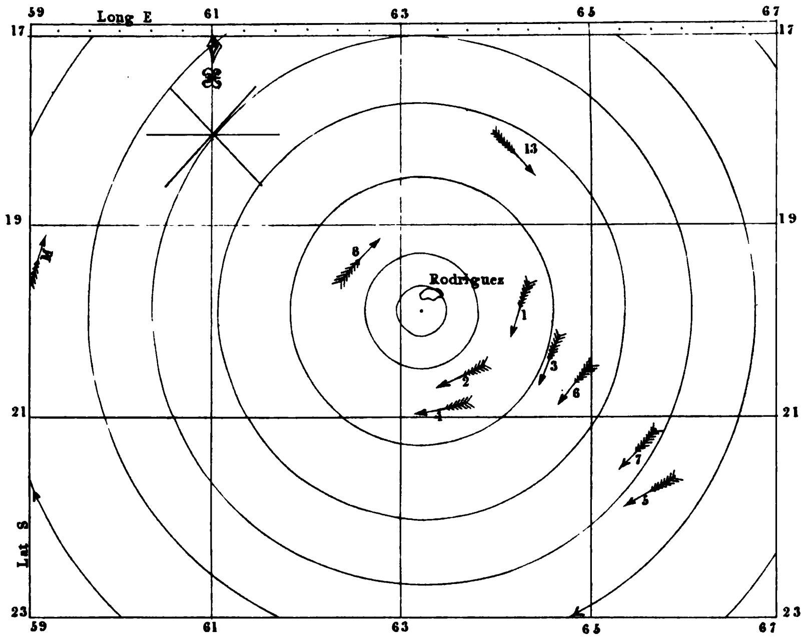
The focus of the hurricane appears to have been to the southward of Rodriguez, in lat. 20° 50′ S., long. 62° 20′ E. We now find its daily progress not exceeding sixty miles, and the direction more southerly, or about S.W. by S., and its violence increasing. If any doubt has hitherto existed with regard to its rotatory character, its progress during the subsequent few days places the fact beyond dispute.

The *Robin Gray*, in the course of twenty-four hours rounded the front of the storm, and found it veering from N.E. to S.E. at noon, when she was in lat. 21° 30′ S., long. 60° 45′ E. It was blowing to an "awful extent." The maintopsail was torn from the yard, and "blown to atoms." The

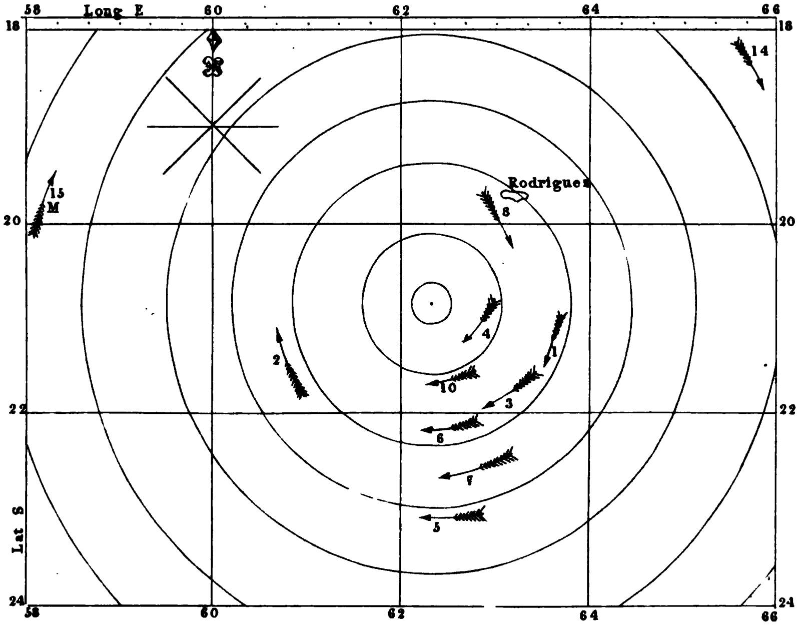
PLATE. IV.

DIAGRAMS VII AND VIII.

No VII. POSITION OF THE RODRIGUEZ STORM ON THE 4th APRIL 1843.



No VIII. POSITION OF THE RODRIGUEZ STORM ON THE 5th APRIL 1843.



sea was making a clean breach over her; the "long-boat was full of water" on deck; and one of the guns, and some of the bulwarks were carried away. The weather was dark and the rain unceasing. She continued scudding under "bare poles before it."

The *Velore* had fallen behind the storm on the previous day, and was lying on its N.W. side. She saw the island of Rodriguez, and at noon was in lat. 19° 57′ S., long. 62° 50′ E., and although at the opposite side of the storm from the *Robin Gray*, she had exactly similar weather, but the wind changing from W. by N. to N.N.W. She was exposed to a "tremendous high *cross* sea," labouring heavily, and shipping a great deal of water. Thus, even in twenty-four hours, after the vortex had passed her, it was only found possible to carry close-reefed topsails.

In lat. 18° 31′ S., long. 65° 46′ E., the *Surat Merchant* had a N.W. gale, blowing in heavy squalls, accompanied by much rain, and "a cross, confused" swell from the westward.

The *Rambler*, hove-to under bare poles, with her head to the centre of the storm, was driving along with it. At noon, in lat. 21° 13′ S., long. 62° 45′ E., it was blowing a complete hurricane from N.E., causing a very "high cross sea." The "fore-topsail was blown from the gaskets," and she sustained considerable damage in her bulwarks, &c.

The *Argo*, on the S.E. side of the circle, had the wind from N.E. to E.N.E. Her course being S.W. and W.S.W., was rapidly leading her towards the centre. While running before the gale, "the fore-topsail was carried clean out of the bolt ropes." She immediately after broached to, and was thrown on her beam ends. By cutting away the mainmast, and heaving part of the cargo over board, the vessel was again righted. She experienced frightful weather, the wind blowing in terrific squalls, with continued rain, and a thick atmosphere. The decks were completely swept by the sea, carrying away the gig, and part of the bulwarks. She was in lat. 22° S., long. 62° 56′ E., with a gale E.N.E.

The *Margaret* could not have been very far from the *Argo*, having the same kind of weather, and was also steering S.W., with the wind at N.E., in lat. 21° 35′ S., long. 63° 15′ E. She was thus approaching the vortex, and found the gale increasing; the sea getting very high, and the ship "straining and labouring so much" that it was found necessary to heave-to. The waves made a clean breach over the decks, carrying away the cook-house, &c. The top sides began to open by the constant working of the hull, admitting the water so fast that it was all the pumps could do to keep her clear.

On this day the *Broxbournbury*, owing to the slow progress of the centre of the hurricane, was enabled to pass round the south-eastern side and get in front of it. Here, however, she was compelled to heave-to, with a violent storm at E., in lat. 22° 15′, long. 62° 30′, somewhat to the westward of her dead reckoning. In the course of the day, the wind changed from N.E. to E.; she lay-to with her head to the southward, by which she exposed herself to the risk of being again overtaken by the storm, as she had been a few days before. The atmosphere was dark and gloomy; incessant rain fell in torrents, and the gale blew in fierce gusts, raising a cross mountainous sea. Under "bare poles," she was labouring much in the trough of the sea; her seams were opening and the water entering so rapidly that a part of the crew were occupied in driving in oakum.

Like the two last vessels, the *Sea Queen*, having passed Rodriguez on the previous day, was steering a W.S.W. course, and rushing right into the middle of the storm. She scudded for twenty hours, and from carrying top-gallant-sails was gradually reduced to a close-reefed main-topsail, under which she was at last obliged to heave-to near the focus, in lat. 22° 40′ S., long. 62° 40′ E.; with a gale at E.N.E., accompanied by incessant heavy rain. Nothing can more clearly show the gradual increase of the strength of the storm, from the exterior towards the centre, than the effects as experienced by this vessel during the twenty-four hours. In fact, each successive reef in the sails might have been considered as an indication of approaching danger.

The *Blanche*, more to the southward than the last ships, by running across the anterior edge of the hurricane, had the wind flitting from E. by N., till, at noon, it was from E.S.E., in lat. 23° S., long. 62° 28′. She experienced a marked increase of its strength in the same manner as the *Sea Queen*, but in a somewhat less degree, owing to her being considerably more in advance of the centre. Nevertheless, from having all sail set, she was reduced in the course of the day to double-reefed topsails. The sea was "high and cross," causing the vessel to labour, and ship seas over all.

The *Waverley*, from the eastward, was steering W. by S., directly towards the path of the storm; and from carrying top-gallant-sails, with the wind *east*, was very soon in the same condition as the *Sea Queen*. Lat. 21° 28′. S., long. 62° 20′ E.

More remote from the rage of the storm, the *Katherine Stewart Forbes*, in lat. 21° 32′. S., long. 68° 20′. E., had a fine E.N.E. breeze, with beautiful weather She was carrying studding-sails low and aloft, rapidly hurrying onward to the scene of danger, little anticipating the peril that lay in her path.

Away at Mauritius, on the opposite side, the wind was at *south*, blowing a stiff gale, but the weather not very bad. The *Gazelle*, at the N.E. end of the island, had heavy squalls, much rain, and was working towards Port Louis under double-reefed topsails, with the wind S. by W. to S.S.W.

Behind the tempest, in lat. 18° 31′ S., long. 65° 45′ E., the *Surat Merchant* had a northerly wind, "decreasing" in strength, with a heavy head sea.

6th April.—Diagram, No. 9.

The vortex of the storm appears to have been about lat. 21° 40′. S., long. 61° 40′. E. Around this spot the wind was blowing with terrific violence, if we may judge by its destructive effects on the vessels which were exposed to it. It would seem that, on this and the subsequent day, it had arrived at its greatest intensity. Before taking into consideration the state of the weather near the centre, it will be interesting to glance at the condition of the atmosphere at some distance around this great whirlwind; for by this we may obtain some information regarding the indications of the vicinity of a storm.

At Mauritius a strong *southerly* wind prevailed, with a rapid scud overhead; but the weather was by no means bad, although the barometer was down to 29° 80′. On the opposite side of the storm, and on its eastern border, about 300 miles from the centre, the *Katherine Stewart Forbes*, in lat. 22° 30′ S., long. 66° 12′. E., was beginning to experience a change of weather. For some days previous, she had had very fine weather, but on this day began to find it squally and wet, and "every appearance of a breeze." A "cross confused sea" caused the ship to "roll heavily," and take a good deal of water on board. She was obliged to take in studding-sails and royals. At noon the wind was E.N.E., the atmosphere hazy, and the sun obscure.

In another direction, the *Parland* had light breezes from E.N.E., in 17° S., 74° E. The *Framjee Cowajee*, in lat. 19° 10′ S., long. 61° 56′ E., had the wind N. to N.N.W., squally, with rain.

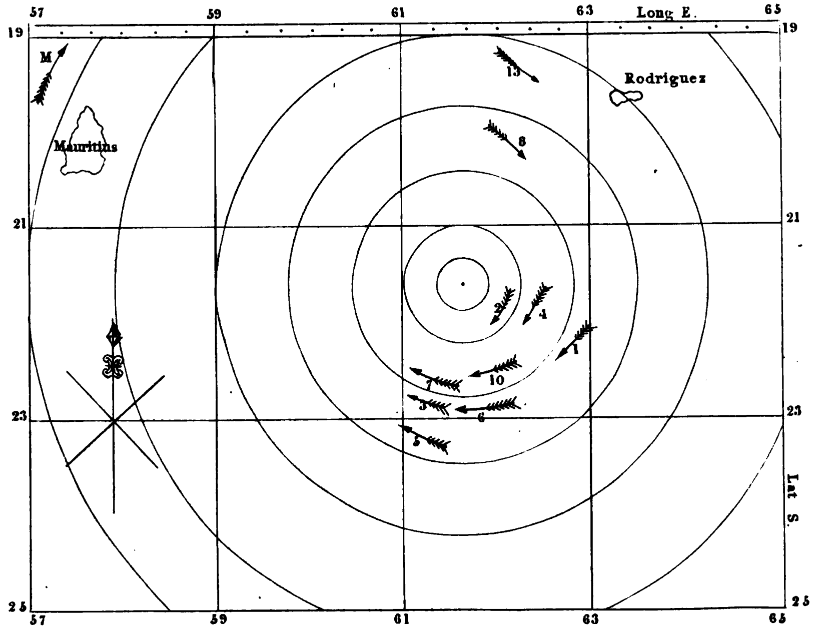
The *Velore*, in the northern half of the circle, had a gale at N.N.W., in lat. 20° 8′ S., long. 62° 10′ E. It was decreasing, and the sky cloudy, with occasional rain and squalls.

The *Margaret* had been lying-to on the east side of the

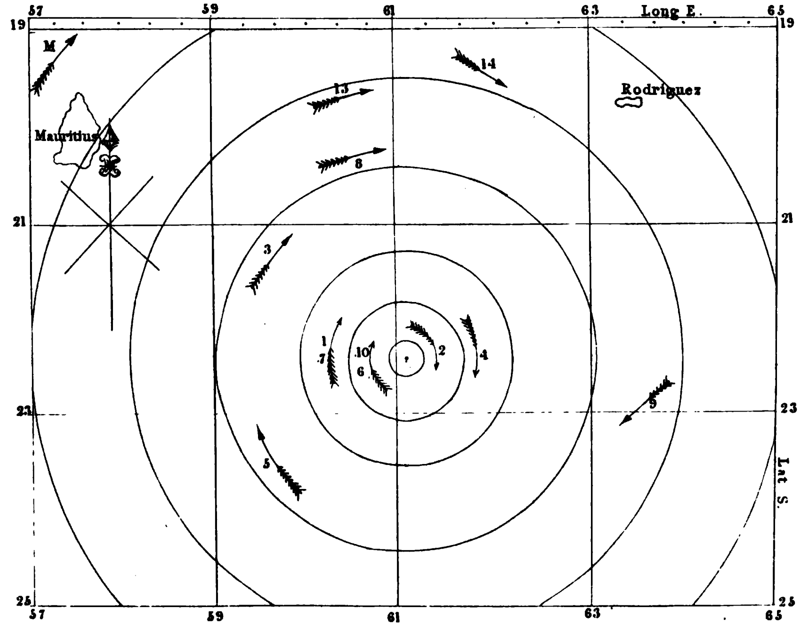
PLATE. V.

DIAGRAMS IX AND X.

No. IX. POSITION OF THE RODRIGUEZ STORM ON THE 6th APRIL 1843.



No. X. POSITION OF THE RODRIGUEZ STORM ON THE 7th APRIL 1843.



focus with her head to N.N.W., and was gradually dropping out of the strength of the tempest. She found the weather improving and the wind moderating; so much so that the foresail and main-topsail were set, and she bore up, at noon, in lat. 22° 8′ S., long. 62° 52′. The hurricane was blowing from N.E., before which she was steering a south-west course directly towards the middle of it.

The *Broxbournbury* lay-to, during the twenty-four hours, in the way of the approaching vortex, with the wind veering from E., to E.S.E., and at noon, must have been about lat. 22° 50′, long. 61° 40′, her head being to S.S.W., and was drifting away before it, under bare poles. She had strong gales, violent squalls, and much rain. The vessel was straining and labouring heavily. The seas were constantly breaking on board of her, and carried away the gig, the starboard quarter-gallery, and the whole of the bulwarks. There were four feet ten inches water in the hold, and the pumps constantly going.

The *Sea Queen*, also hove-to near the centre of the storm, had it " blowing most violently," with a " tremendous sea" and constant heavy rain. The ship was rolling heavily in the trough of the sea. The iron tiller of the rudder was carried away about nine inches from the head, and the vessel fell off in an unmanageable state. The driver, close-reefed, was hauled out to steady her, but was blown to ribbons in an instant. She appears to have had the wind veering from E.N.E., to S.E., when in lat. 22° 30′ S., and long. 61° 20′.

The *Argo*, with her foremast alone standing, contrived to run before the tempest, and by steering W.N.W. crossed its track somewhat in front of the vortex. She had similar weather to that experienced by the two last vessels, and a dreadful sea making a clean breach over the ship, clearing her decks of almost everything. Although before the wind, the fore-topsail blew adrift from the yard and went to pieces. The wind veered from E.N.E. to E.S.E., in lat. 22° 40′ S., and long. 61° 10′ E.

The *Rambler* hove-to, with her head to the westward, under "bare poles," found it blowing a "mere hurricane." An "enormous high cross sea" was running, and the vessel was "shipping tuns of water on deck;" however, she was slowly dropping behind the storm, which was veering from E. to N.N.E. At noon, in lat. 22° S., long. 62° 22′.

The *Robin Gray*, at the commencement of the twenty-four hours, was on the S.W. side of the vortex, almost in front of it; but by scudding "right before it," under "bare poles," she almost described a circle, and had the wind veering from S.E. to S.W., W., N.W. north, and finally at N.E., when, in consequence of her broaching-to, and being thrown on her beam-ends, she was obliged to lie-to in lat. 22° 2′ S., long. 61° 50′ E. We refer to the extracts from her log regarding the weather, and the damage which she sustained.

We find the *Waverley* in the course of yesterday scudding towards the centre of the storm, and by about 4 P. M. of this day, in consequence of the gale increasing to a hurricane she hove-to under close-reefed main-topsail, near the advancing focus; but she appears to have been as badly off in lying-to, as the *Robin Gray* in running round the fatal circle. The ship was rolling heavily, and the waves were breaking over her, washing away the starboard bulwarks, and doing other mischief. Towards noon, the wind became more moderate, with alternate lulls and gusts, but the atmosphere continued thick and hazy, with rain, and the sea undiminished in violence. At noon, in lat. 21° 40′ S., long. 61° 50′ E., she had the wind at E. by N., and appears to have been actually in the margin of the calm which is experienced near the centre of a revolving gale.

In front of the storm, in lat. 23° 10′ S., long. 61° 10′ E., the *Blanche* had a hurricane blowing at S.E., and "the sea making a clean breach over her." Lying almost on her beam-ends and a "tremendous sea running."

7th *April*.—DIAGRAM, No. 10.

According to our calculations, the centre of the storm was in lat. 22° 30′ S., long. 61° E., about noon. Near this a number of vessels were assembled within a narrow compass, as if they had been successively intercepted in their progress, and drawn into the vortical part of the hurricane.

At the edge of the vast circle, in lat. 19° 32′, long. 61° 51′ E., the *Surat Merchant* had a N.W. wind; at Port Louis it was at S.W.; in lat. 23° 30′, long. 59° 40′ E., by the *Blanche* it was at S.E.; and in lat. 22° 58′, long. 63° 40′ E., it was at N.E.; thus forming the four sides.

In the course of yesterday, the *Margaret*, after lying-to for some time, had recommenced running S.W., and continued to do so for eight or ten hours; she speedily got into the fiercest part of the storm; the raging elements each moment increasing in violence, till at midnight it "was a perfect hurricane." The trusses of the foreyard were carried away, and "the fore-topsail was blown to pieces." Soon after midnight the main-topsail was blown from the bolt-ropes, and the mainsail from the gaskets "when furled." The spanker, close-reefed, was set, but almost immediately after, blown to pieces. A tremendous sea was running, constantly breaking on board, which carried away the long-boat and stove it to pieces. At 5 A. M. the ship was struck by a heavy sea on the quarter, which carried away the rudder and the head of the stern-post; at the same time the ship's cargo, stores, and the tier of water-casks in the hold were started. It was found necessary, for the safety of the ship and masts, to cut away the fore and main yards, which were carried to leeward by the force of the storm, according to the description of an eye-witness, like "arrows on the wind." This vessel appears to have been near the focus, and in the twenty-four hours had the wind from N.E. veering by S.E. to S.S.W. At noon was in lat. 22° 20′ S., long. 60° 20′ E.

On the *Sea Queen* the effects of the storm appear to have been most disastrous, and nothing but the fact of her being a strong-built new teak ship could have prevented her from foundering. In the early part of the twenty-four hours her position was exactly in front of the vortex, with the hurricane at S.E., veering, as it passed by or over her, to S.W. at noon, when in lat. 22° 23′, long. 60° 20′. She was lying at the mercy of the waves and wind, "labouring in the trough" of the sea. At 4 P.M., found it "moderating" *very much,* which caused her to strain, and "ship seas constantly." At 6 P.M., "vivid lightning" was observed, attended by "heavy squalls" and "*sudden calms.*" It now recommenced to blow from the S.W. with such fury that the foresail and fore-topsail were blown from the yards, and the fore-topmast carried away. At midnight it was "a perfect hurricane, with a tremendous cross sea running, and ship rolling most violently." It was "raining most furiously, and constant vivid lightning," during the night. At 1 P.M., a furious gust carried away the mainmast by the deck, which fell over the poop. At 2h. 30m. A.M., the mizenmast, having no support, fell over the taffrail. In this situation, with the wreck of her masts entangled about the hull, threatening to stave in her side, she lived through the dangers of that awful night, exhibiting in her dismantled state a terrific evidence of the dangers to which vessels are exposed, when helplessly drifting about near the centre of a hurricane.

The *Waverley,* at the commencement of the twenty-four hours, was also in or near the vortex, setting additional sail, and directing her course to the S.W., in the same direction as the storm was moving. The weather appears to have been "*moderate*" for a few hours, but this delusive appearance did not last long. At 10 P.M., the "gale increased rapidly, veering all round the compass." At 11 P.M., a "tremendous hurricane" obliged her to be "hove-to under bare poles." A.M.—Still "blowing a hurricane, with thunder, lightning, and rain." The vessel was "on her beam-ends," with the starboard side under water. The foremast was cut away to relieve her. At the same time, the main and mizen-topmasts, with all their rigging, were carried away by the tempest. She lay like a log in the water, with the waves breaking clean over her, sweeping away boats, bulwarks, &c. One sea carried away the whole of the cabins and their contents off the poop; at the same time there was four feet water in the hold, and the pumps incessantly going. She had the wind veering from S.E. to S.W., and at noon was in lat. 22° 30′ S., long. 60° 40′ E.

The *Robin Gray* was also near the vortex, but after having been thrown on her beam-ends the previous day, less attention appears to have been paid to the log-book; we are, therefore, at some loss regarding her true position, and the veering of the wind. But she must, however, have been near the *Waverley*, from the lull of the tempest which was experienced about the beginning of the twenty-four hours, and seems, by the position of her head, to have had the wind from the eastward. The weather was exactly the same as that encountered by the other vessels, but the lightning and thunder in a more intense degree, and the sea was "high, cross, and turbulent." The sails were blown from the yards. She appears to have been in about lat. 22° 20′ S., long. 61° 30′ E. The wind is noted as having been at N.E. the whole day; but we have good reasons for thinking, from information collected on board the vessel after the storm, that no attention was paid to it at the time, and it was only some days after that it was entered in the log; consequently no importance can be attached to it.

The *Broxbournbury* lay-to all the twenty-four hours on the S.W. side of the circle, with her head to the southward and the wind veering from E.S.E. to S. The weather which she experienced differed in nothing from that which we have described, except that there is no mention of lightning having been seen. She sustained extensive injury, had five feet water in the hold, and the pumps constantly going. At noon "a heavy hurricane; ship could no longer lie-to, and was kept away before the wind to save ship and crew." At noon in lat. 22° 35′ S., long. 60° 40′ E.

A little to the westward of the track along which the storm was advancing, the *Blanche* was hove-to, with the wind at S.E., and her head to S.S.W. Like the other vessels, she had a thick hazy atmosphere, incessant rain, and heavy squalls. The sea was constantly breaking on board, sweeping the decks, destroying the bulwarks, &c. No mention is made of lightning having been seen. Her position appears to have been about lat. 23° 30′ S., long. 59° 40′ E.

The *Rambler* also lying-to, but behind the vortex, had the wind from *north* to N. by W., in long. 61° 49′ S., lat. 22° 30′ E. She was slowly dropping out of the gale, but still suffered from a "high, confused, and beaming sea," causing the vessel to roll "enormously," and doing a great deal of damage. The weather was hazy, and accompanied by much thunder and lightning, with heavy rain.

On the same day, the *Argo*, having rounded the storm with an E.S.E. wind, kept away N.W. before it, and, in twenty-four hours' time, from a heavy gale and sea causing the ship to labour and strain, she was in fine clear weather, in lat. 21° 10′ S., long. 59° 53′ E., with a S.W. wind.

The *Velore* had been hanging on the skirt of the gale for several days, being delayed in her voyage to Mauritius by the S.W. and W. wind at that half of the circle where she was. This day, in lat. 20° 25′ S., long. 60° 30′ E.; the wind was at S.W.

The *Framjee Cowajee*, in lat. 19° 42′ S., long. 60° 20′ E., had a W.S.W. breeze, squally, with rain, and "a high sea from south," as if it "had been blowing." It must be remembered, that for the ten previous days this vessel, although following in the rear of the storm, and actually sailing in its wake, never got into it a second time.

While the hurricane was raging with its utmost violence, and wreaking its fury on the devoted little fleet of vessels now lying dismasted within its vortex, we have seen the *Argo,* by scudding N.W., get into moderate weather. If we turn to the eastward, we find the *Katherine Stewart Forbes* steering westward to the scene of danger. On the previous day, in nearing it, she had taken in her studding-sails, and began to experience bad weather. On this day, as she got to the westward, she encountered a "heavy cross sea," causing her to roll and strain. In twelve hours more, during which she was reducing sail, it was blowing a "tremendous hurricane, with a confused cross sea running N.E. and S.E." The ship was rolling awfully, and burying herself in the waves. She had five feet water in her hold, and the crew when working at the pumps were up to their middle in water. The waist was full of water till the bulwarks were swept away, when she was relieved of this. At noon, in lat. 22° 58′ S., long. 63° 40′ E., had the wind at E.N.E.

8th *April.*—DIAGRAM, No. 11.

We trace the centre of the storm to about lat. 23° 20′ S., long. 60° 40′ E., still displaying undiminished violence, and equally well developed in all its essential characteristics. The greater number of the ships that were yesterday exposed to its fury, were lying behind the vortex, still helpless, and buffeted about by the gale and the tremendous sea, which told with fearful effect on their shattered hulls.

The *Katherine Stewart Forbes* alone was in the front of the focus. She was scudding to the westward with the wind at east changing to S.E. At noon her lat. 23° 30′ S., long. 60° 50′ E. " A severe hurricane and tremendous sea running." The ship completely " burying herself in the sea and labouring awfully;" could not venture to heave-to for " fear of the sea sweeping the decks." The vessel became so dead in the water that she was considered to be settling down, when it was decided that it would be necessary to throw cargo overboard to lighten and keep her afloat. Her log gives the details of damage sustained.

The *Margaret*, on the opposite side of the vortex, still had the "hurricane strong" from S.W. by W., with a heavy sea, which broke on board and carried away the quarter-boat and davit. Lat. 22° 8′ S., long. 60° 30′ E.

The *Waverley*, also in the same part of the gale, had it from S.W. to W.S.W., in lat. 22° 20′ S., long. 60° 30′ E. She was still almost on her beam-ends with the sea breaking over her, the pumps constantly going, and part of the crew throwing cargo overboard. The wind and weather, however, were gradually getting less severe as the storm moved away to the S.W.

The *Blanche*, to the westward of the vortex, in lat. 23° 30′ S., long. 59° E., had drifted out of the more severe part of the hurricane, and from a S.S.E. wind had it at south about noon. She experienced considerable injury during the twenty-four hours.

On the N.E. side of the circle, the *Rambler* was dropping out of the gale and from severe weather, by noon, had got a light breeze at north, in lat. 22° 58′ S., long. 62° 30′ E.

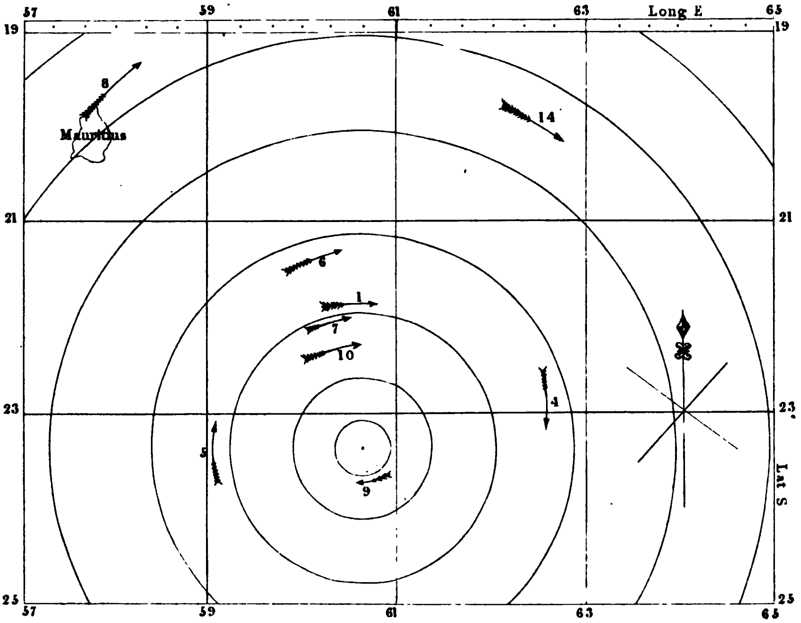
The *Sea Queen*, helpless and unmanageable, was falling out of the gale. " At sunset she had a heavy storm with a tremendous sea running, constant rain, and the ship rolling fearfully in the trough of the sea." By the next morning, however, the violence of the wind had abated, and her

PLATE. VI.

DIAGRAMS XI AND XII.

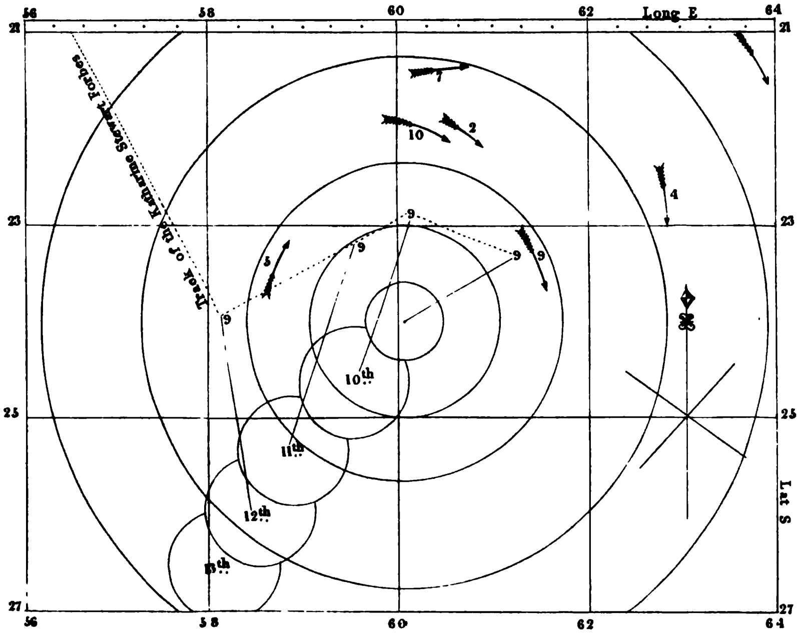
N° XI.

POSITION OF THE RODRIGUEZ STORM ON THE 8th APRIL 1843.



N° XII

POSITION OF THE RODRIGUEZ STORM ON THE 9th 10th 11th 12th & 13th APRIL 1843.



exhausted crew began, with reviving courage, to clear away the wreck of the masts. At noon she had a strong breeze from S.W., in lat. 21° 53′ S., long. 60° 37′ E.

The *Broxbournbury*, being unable to lie-to any longer, bore away N.W. before the wind at S.E., and thus ran out of the way of the vortex. By adopting this course she escaped from "a heavy hurricane, and a sea that swept the decks, carrying away an anchor, boats, &c.," and ere she had got 100 miles to the N.W., she had comparatively moderate breezes. In twenty-four hours the wind changed from south to S.W. at noon, lat. 21° 32′ S., long. 60° 12′ E.

We cannot give much attention to the *Robin Gray's* log on this day, for the reasons already assigned. She appears to have had severe weather, but it was gradually getting better, showing that her position was behind the storm. Her latitude must have been about 22° 45′ S., long. 61° E. The wind is put down at south, but is so completely at variance with every other vessel near her that we must consider it as incorrect.

The *Velore*, in lat. 19° 28′ S., long. 58° E., had fine weather, a south-west wind and S.S.W. swell. Occasional squalls.

The *Surat Merchant*, in lat. 20° 3′ S., long. 61° 30′ E., had a breeze from west and a W.N.W. swell.

The *Wellington*, in long. 65° 30′ E., lat. 19° 25′ S., had a W.N.W. wind, squally, with rain, and a heavy head sea.

Farther off, in the wake of the gale, the *Parland*, in lat. 18° 34′ S., long. 69° 37′ E., had an E. by N. wind. By which we perceive, that at this distance, the trade had begun to resume its ordinary direction, after its derangement by the storm.

April 9.—DIAGRAM, No. 12.

The vortex, according to our calculations, must have been in lat. 24° S., long. 60° 10′ E. It still embraced a number of vessels within its range, sufficient to demonstrate its unmitigated violence, and extent.

The *Blanche*, on the west side, had the barometer rising, and was gradually getting into more moderate weather and smoother water. She had the wind at S.W., in lat. 23° 24′ S., long. 58° 40′ E.

The *Rambler*, on the reverse side of the storm, in lat. 22° 48′ S., long. 62° 44′ E., had a fresh breeze from N.N.E.

The *Katherine Stewart Forbes* was the only vessel near the centre of the storm on this day. It was "blowing furiously," and an "outrageous sea was running." She was hove-to, one-half of the crew throwing cargo overboard, and the other at the pumps. The bowsprit was carried away, with all the bulwarks, stanchions, &c. The guns and other heavy articles were thrown overboard. Even towards the end of the twenty-four hours, it is described as having still been a "tremendous hurricane." The vessel was hove-to on the larboard tack, with her head to the westward, and gradually fell off during the day to N.E., showing the wind to have veered from S. by S.W. to N.W., where it was at noon, in lat. 23° 20′ S., long. 61° 30′ E. She scudded thirty miles to the N.E. before the wind, while employed in securing and clearing away some of the wreck. This carried her sooner out of the range of the gale than she would otherwise have been.

The *Waverley*, in lat. 22° S., long. 60° 20′ E., had a W.S.W. to N.W. wind, moderate and cloudy weather, but a heavy swell continued.

The *Sea Queen*, in lat. 21° 26′ S., long. 60° 21′ E., had a *west* wind.

The *Velore* and *Broxbournbury*, near one another in lat. 20° 3′ S., long. 58° 58′ E., had the wind W.S.W., fine weather, and a confused swell.

The *Surat Merchant*, in lat. 19° 31′ S., long. 61° E., had a W.N.W. breeze, a heavy sea, and fine weather.

The *Wellington*, in lat. 20° 37′ S., long. 64° E., had a squally N.W. wind, with small rain, and S.W. sea.

April 10.—DIAGRAM, No. 12.

From this date we have not such information as may be considered sufficiently decisive in determining the further progress and features of this storm. Its course, however, to the S.W., or S.W. by S., is pretty clearly made out for a few days longer by means of the *Katherine Stewart Forbes.* This vessel attempted to continue her progress to the Cape of Good Hope, by which she hung in the rear of the circle.

On this day its focus was, in all probability, in lat. 24° 40′ S., long. 59° 15′ E.

The *Katherine Stewart Forbes,* in its wake, still had "strong breezes, and was rolling and shipping a great deal of water on deck." About noon, in lat. 22° 53′ S., long. 60° 4′ E., she had the wind N.N.W.

The *Blanche,* also near to the gale, had a W.N.W. wind, blowing fresh, with squalls, and a heavy sea; lat. 22° 4′ S., long. 58° 4′ E.

The *Margaret,* in lat. 21° 5′ S., long. 60° 30′ E., had the wind W.N.W., with occasional squalls.

April 11.—DIAGRAM, No. 12.

The vortex must have been about lat. 25° 30′ S., long. 58° 50′ E. The *Katherine Stewart Forbes,* following it, was in lat. 23° 21′ S., long. 59° 38′ E., and experienced unsettled, squally weather, a heavy swell, and the wind at N.W.; still showing the S.W. course of the tempest.

April 12.—DIAGRAM, No. 12.

The same vessel, in lat. 24° S., long. 58° 14′ E., had the wind N.W. to W., moderate and fine. On this day she bore up for the Isle of France.

There are no means of tracing this storm to its termination, but it would appear to have pursued its course somewhat farther to the south-westward, or broken up soon after the 12th April. At this time the *Pauline Houghton* and

Briton, on their way to Mauritius, were approaching the island from the southward, in the meridian of 58° and 60°, but without experiencing anything like a hurricane; we must therefore assume that it did not turn to the S.E., otherwise it must have passed over them.

The only account of the state of the barometer during this gale which is worth noticing, is that kept on board the *Velore*, and is given further on.

It may be useful to close this by a brief abstract of the periods and places where indications of a vortical motion of the atmospheric currents were successively noticed along the tract followed by the storm, and marked No. 1 track on the Chart, adopting "civil time," and degrees, without the odd miles.

On the 23*rd March*, lat. 11°, long. 98°.—The *Katherine Stewart Forbes* had a squally gale from W.S.W. to S.E., with heavy rain.

March 26*th*, lat. 10°, long. 84°.—The *Velore* had a S.S.W. wind, and barometer 29.60; the *Sea Queen* S.S.E., and *Katherine Stewart Forbes* E.S.E.

March 29*th*, lat. 13°, long. 78°.—The *Framjee Cowajee* had it veering S.S.E. and S.S.W. to West and N.W., where, two days before, it was S.E.

April 1*st*, lat. 15°, long. 70°.—The *Sea Queen* experienced a gale from S.S.E. to south-west, N.W. and N.E., in twenty-four hours.

April 3*rd*, lat. 18°, long. 64°.—The *Argo*, under bare poles, had a sudden abatement and recurrence of the gale, veering S.E., S.W., West N.W., North and N.N.E.

April 4*th*, lat. 20°, long. 63°.—The *Velore*, under bare poles, had a storm from S.E., South, S.S.W., W.S.W. to N.W. The hurricane was at Rodriguez.

April 6*th*, lat. 22°, long. 62°.—The *Robin Gray*, under bare poles, scudded round a circle, with the wind veering S.E., S.W., N.W., North, and N.E.

April 8*th*, lat. 64°, long. 61°.—The *Katherine Stewar Forbes*, under bare poles, had the storm S.E. to S.W., N.W., and North, "all round the compass."

All the vessels approaching the storm's path from the eastward had an easterly wind, and, after they crossed it, found it westerly.

SECTION IV.

ON STORMS IN THE INDIAN OCEAN SOUTH OF THE EQUATOR —THEIR GENERAL CHARACTER, AND SIMILARITY TO ONE ANOTHER.

Assuming that the facts connected with the hurricane referred to in the last section are conclusive with regard to the points more immediately in question, it next becomes necessary to inquire how far they are conformable to the phenomena distinguishing other storms, which have occurred in the same season of the year, and passed over the same tract of ocean.

To arrive at a correct knowledge of the path of these terrible visitors, is perhaps the most important object of all. On the chart at the commencement of the volume, the general track of the Rodriguez storm is laid down by means of a series of circles, indicating the rate of its diurnal progression. On the same chart we have also traced out the course of several others, as near the truth as our calculations, and the detached and incomplete nature of the information which we possess with regard to some of them, would permit. The result shows that the greater number of those with which we are acquainted have followed a common track, extending from the neighbourhood of Sumatra and Java towards the Cape of Good Hope, and, apparently, terminating about 45° or 50° E. and 28° or 30° S. These storms may vary a little in their curve from the equator to the tropics, and their course be a few degrees more to the eastward or westward; yet it would seem that there is a constant tendency to move onward in a determined direction. Another track, farther to the eastward, is occasionally frequented by rotatory gales, commencing about 10° S. and 130° or 140° E., near the island of Timor, and ending about 80° to 90° E. and 26° to 30° S. With this last, however, we are so little acquainted, that we can merely advert to the few storms which establish the fact. Of the hurricanes in the Mozambique Channel we know still less, and can only add one to that already traced in the " Law of Storms."

It is principally intended to confine this investigation to the first great line of storms, because it is nearly that of the track of all vessels from India, China, and the East, bound to Mauritius or round the Cape of Good Hope. Perhaps from this very circumstance we are more familiar with the subject, and are afforded better opportunities of ascertaining the great frequency of their recurrence along the tract of ocean in question. Still, as ships are traversing all parts of the Indian Ocean, this is scarcely sufficient altogether to account for the tracing of hurricanes to one or two localities, or to explain the numerous contiguous lines on the chart, each indicating the occurrence of a storm at some point of the general track. We are also struck by the fact that the small portions of lines, pointing out an ascertained storm at opposite ends of the common path, although happening at intervals of many years, might almost be united together into a number of continuous curves nearly parallel to each other. It may also be inferred that there are one or two regions in the Indian seas, south of the Line, where hurricanes are formed, and whence they move toward the tropics by regular veins. Whether the clear spaces on the chart are occasionally visited by storms, is a question for future observation.

It has been computed, in the last section, that the diurnal rate of progression of the centre of the Rodriguez hurricane was about 220 or 230 miles during its early stages, and that it gradually diminished till, when near the tropic, it scarcely exceeded fifty miles. This is borne out by the fact that vessels were in the first instance overtaken by the storm, and subsequently ran into it a second time. In the storms about to be traced, it will be seen that in these respects a remarkable coincidence exists. With regard to the rotatory action of the Rodriguez storm, and the direction of its revolution from east to west, by south, agreeable to the views of Colonel Reid and Mr. Redfield, it is scarcely possible to raise an objection. The facts proving this for so many successive days cannot easily be controverted.

The diagrams illustrative of the course of the Rodriguez hurricane were drawn up within a few days after the arrival of the vessels at Port Louis, and while there were means of obtaining much information never given in log-books, but not the less important in determining the path of a storm. The subject was treated as an abstract question, unconnected with previous notions or theories. Since our arrival in England, and having had access to the ships' journals of Messrs. Green and Co., and others, additional, although less complete facts, have been gleaned and placed in juxtaposition. How far they agree is now to be seen. Although informed of the views of Mr. Redfield and Colonel Reid, through the medium of the periodicals, we had no opportunity of examining the "Law of Storms" until very lately. This is mentioned simply for the purpose of showing that isolated observations, apparently almost conjectural, on being collated and presenting uniform results, tend to render the general inferences more decisive. The information derived from only one, or even two, vessels involved in a hurricane, is seldom sufficient to demonstrate the fact of the wind blowing in a circle; but, *cæteris paribus*, when the veering of the gale is to a certain extent analogous to that which takes place in cases fully made out, we must be allowed to assume that the whole is complete.

As to the violence of the wind, the state of the sea, and other circumstances which constitute a hurricane, there can be no doubt. Therefore the instance of a single ship is decisive in proving *when* and *where* they occur. It is necessary, however, to guard against the error that a vessel cannot be in a hurricane without sustaining severe loss; that of Rodriguez proves that one may carry away every mast, and another, equally near the focus, may not lose a spar. In the Culloden storm, off Rodriguez, a brig lived through a tempest and sailed round its vortex, while a line-of-battle ship and a frigate went down.

We take the liberty of availing ourselves of the information collected by Colonel Reid concerning the Mauritius gales. In fact, the interest created by reading a review of this gentleman's work on storms drew our attention to the subject, and induced us to satisfy ourselves of the truth of the rotatory theory.

In tracing the course of hurricanes we shall have occasion to refer frequently to the state of the weather and sea at Mauritius, as indicating the passage of a revolving storm near the island. It may be well to state that the observations quoted are from a meteorological register kept during the years 1839, 1840, 1841, and part of 1842 at the military post of Souillac, situated on the very southernmost extremity of the island. It is a spot well adapted to such a purpose, being exposed to the S.E. trade, southerly, and S.W. winds, which blow from the sea uninterrupted or diverted from their natural directions by the high land of the island. The post is established on a bluff headland overhanging the ocean within twenty yards of the beach; so near, indeed, that the deafening noise of the huge rollers, breaking on the reef, on certain occasions almost painfully force their presence on the notice. Whenever the general circumstances combined to induce the belief that a storm was impinging on the island, it was noted down; and, in many instances, subsequent information has proved its correctness.

When a vessel encounters bad weather, in the hurricane season and latitudes, it becomes a point of the first importance to know the distance and bearing of the vortex of the gale. The direction of the storm and fall of the barometer are a sufficient guide for this purpose, but of course greatly assisted by the existing force of the wind, state of the sea, &c. A vessel may be hove-to, or under close-reefed topsails, and yet not within 100 miles of the focus. On the 4th April, when the centre of the Rodriguez gale was over that island, the *Gazelle,* working into Port Louis harbour, and 300 miles off, was under double-reefed topsails; and nearly as far on the opposite side, the *Blanche* was under the same circumstances; and both with winds forming a part of the circle. Therefore, in calculating the distance of vessels from the centre of the hurricane in which they were involved, we have applied the Diagram No. 19, as showing what is about the mean depression of the barometer at different points around the focus. This, of course, is employed on the assumption that the mean fall of the mercurial column near the vortex is to the extent of one inch, and from thence decreasing in regular gradation towards the exterior of the circle. It is probable that the errors arising out of such an arbitrary method of calculation do not exceed thirty or forty miles, and therefore cannot seriously affect that which is most important to be fixed,—the general track of storms, embracing a width of eight or ten degrees.

The set of hurricanes to be first considered are those which have been encountered farthest to the north-eastward, and consequently nearest to the locality where they originate. They are met with, in about lat. 10° to 12° S., and long. 80° to 90° E., moving from the eastward in the direction of W.S.W. along the track of variables separating the westerly monsoon from the S.E. trade-wind. Hence vessels when they leave the former, by keeping well to the southward to get into the strength of the latter, are led across this very path. We shall presently see the various ways by which they come in contact. Cases will also occur where ships, after having disentangled themselves at this part of the track, continue their voyage to the westward and again come up with the same storm, at its termination, or when its daily rate of travelling has been diminished. Hence we are enabled to calculate the mean time which a hurricane takes to run its ordinary course. That of Rodriguez was first discovered about the 28th of March, in 86° E. and 10° or 11° S., and it was finally lost sight of about the 12th of April, in 26° S., 58° E.,—thus travelling along the ordinary route in fifteen or sixteen days. Others seem to have been nearly similar in this respect, and the more complete our information is with regard to their rate of progression, the more fully is this confirmed. Indeed, this remark is equally applicable to the whole of the phenomena developed by rotatory gales.

THE "ALBION'S" STORM OF 1808.*

(*No.* 2 *track on the chart.*)

This storm, mentioned by Colonel Reid, seems to have occurred as far east as long. 91° 23′ E. Having only the log of one vessel given, little else is known beyond its extreme violence, and disastrous consequences. The place where it occurred is fully ascertained to have been between the monsoon and trade wind, in lat. 10° 6′ S. It appears that the *Albion* found the weather getting bad on the 20th Nov. in lat. 9° 41′ S., long. 90° 52′ E., with the wind at W. by S., veering to W.N.W. On the 21st she was lying-to, when the vortex appears to have passed over her, the wind going round from W.N.W. to N.W. and N.E. While near, or in the centre of the hurricane, the wind seems to have blown from every point of the compass. All the vessels belonging to the fleet "experienced a lull in the midst of the storm" for an hour or two.

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* An attempt to develope the Law of Storms, by means of facts arranged according to place and time, and hence, to point out a Cause for the Variable Winds, with the view to Practical Use in Navigation.—By Lieut.-Col. Reid, C.B., Royal Engineers.

Colonel Reid does not think that this storm was "moving onward at first." It is not very improbable that this was the case, or at least that the direction of the vortex was not straight, but moving about in a gyratory manner. As it was near the region where hurricanes are formed, it may have been acquiring that strength which gives permanency and consistency of action to its subsequent progress. However, as the approach was gradual for twenty-four hours, and in forty-eight hours its violence was over, it argues that, even if occasionally swerving from its ordinary track, on the whole, its diurnal progression must have been as rapid as usual. It would seem that the *Albion fleet*, in steering south, while the storm was passing to the westward, ran right into it, and dropped out at the after part of the circle.

THE "GANGES'" STORM OF 1836.*

(*No.* 3 *track on the chart.*)

Is another instance where a rotating gale is experienced on leaving the monsoon, and apparently moving in the same direction as the last. A vast revolving circle of atmosphere, of a diameter of 500 or 600 miles, must necessarily be connected with the two great winds between which its focus is moving. Hence, when traversing the westerly monsoon towards the southward, ships find it increasing in violence as they near the confines of the trade-wind.

The *Ganges* seems to have been approaching the storm while it was passing a-head of her to the westward. On the 7th Nov., when in lat. 10° 15′ S., long. 84° 21′ E., the wind was about N.N.W., blowing a severe gale, and the barometer down to 29° 55′. It is clear from this, however, that she could not have been nearer to the vortex than 100 miles. This is rendered still more probable by the circumstance of the *Thalia* being dismasted on the same day, in lat. 12° S., long. 85° E. The centre, therefore, must have been about the position of the latter vessel. Next day the *Ganges* had a NW. wind, and on the 9th it was northerly and light,—thus indicating that the storm was to the westward, and remote,—doubtless moving with its accustomed velocity in this latitude, but leaving behind the heavy "confused swell" so characteristic of a rotatory gale.

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* See Law of Storms, by Colonel Reid.

THE "CARNATIC'S" STORM OF 1838.

(*No. 4 track on the chart.*)

The circumstances under which this vessel got entangled in a hurricane, as well as the situation where it took place, are so very similar to those just related, that, by altering dates, they might be considered as the same.

The *Carnatic*, on her passage from Bombay to England, after crossing the equator, was running through the westerly monsoon. On the 24th February, when in lat. 6° 37′, long. 82° 9′ E., she found the wind increasing, accompanied by squalls and rain from the W. and N.W., and was obliged to take two reefs in her topsails. At the same time a heavy swell from S.E., "and other threatening appearances," led to preparations for a gale.

Next day she found the same weather, and an increasing gale from N.W. to S.W. Her course was south-west, with three reefs in her topsails. At noon she met in with a "confused sea" from S.E., in lat. 8° 30′ S., long. 82° 2′.

On the 26th, the weather had all the character of a hurricane blowing at S.W. "At 6 P. M. the gale suddenly ceased, and it *fell* *quite calm*—the ship pitching deep and striking her counter heavily. At 10 P. M., after light calms, the wind came away from the N.E. as a fresh gale and in violent squalls." It veered from N.E. to N. and N.W. The latitude and longitude are not given on this day, but she must have been about 11° S. and 82° E.

Here the centre of the storm is also felt in a tract separating the monsoon from the trade. A lull or calm of four hours takes place, and the wind, after leaving off at S.W., recommences from the very opposite point with equal violence. Had this vessel hove-to, or steered due south, she must have gone clear of the gale.

On the 27th, however, she continued her course to the S.W. at the rate of 8 and 9 miles an hour. "The storm was blowing from N.W. with tremendous violence. She was scudding under bare poles with the topsails stowed." "At 10 A. M., the sea running to a tremendous height and the ship rolling nettings under water," and the gale "blowing with unabated violence." At noon, in lat. 13° 9′ S., long. 81° 33′ E. At 4 P. M., the same weather and sea, considerable damage was sustained from the latter breaking on board. Still scudding S.W. by S., and the wind veering N.W. to N. by W.

The *Carnatic* was evidently running after the hurricane. On the 28th she still pursued a S.W. course, at 9 miles an hour, during the whole twenty-four hours of this day. The usual kind of weather near the centre of a storm was experienced. "At 8 P. M., the gale increasing in violent gusts," and "a heavy sea breaking over all." The wind N. by W. to N.N.E., lat. 15° 21′ S., long. 79° 14′ E.

On the 1st March, still running S.W. by W. at the same rate as on the previous day. The wind at N.N.W. to N.W., the same kind of weather, "violent squalls with lightning and heavy rain." "A high confused sea." The ship labouring heavily and shipping "seas over all." At noon in lat. 16° 5′ S., long. 76° 6′ E.

On the 2nd March, "the wind N.W. by N. to north. A heavy *cross* sea running." Steering S.W. by W. at the rate of 7 miles per hour. Attempted to set one of the topsails, close-reefed, but obliged to stow it again. Lat. 18° 45′ S., long. 74° 4′ E.

On the 3rd March, steering S.W., with a wind N.N.W., but her rate of going gradually diminishing to 5 and 4 miles an hour. The weather still squally, and the sea on this day carried away some of the bulwarks. For the first time in six days she was able to carry a fore-topsail. At noon, her lat. 21° 1′ S., long. 73° 17′ E.

On the 5th March, the wind N.W. moderating. The sea going down. Lat. 22° 68′ S., long. 68° 45′ E., and next day it was fine.

Instead of lying-to, as the *Albion* and *Ganges* did, the *Carnatic* continued to scud for six days in the wake of the storm, and thus exposed herself to the kind of weather described. She kept nearly apace with it, but by steering a point or so more to the southward of the direction pursued by the storm, she seems to have slowly extricated herself from it, and as her rate of sailing was lessened, she soon got better weather. In the Rodriguez storm, we find vessels in front of the hurricane keeping before it with a S.E. to S.W. wind for a day or two, but the vortex gradually came up and passed them. On the same path we see the *Carnatic* behind another storm, with a N.W. to N.E. wind accompanying it for nearly 1000 miles. The track; rate of travelling; and other circumstances are so much alike, that, but for a difference in time, they might be considered as the same. The state of the barometer is not given in this ship's journal.

THE "EARL OF HARDWICKE'S" STORM OF 1840.

(*No. 5 track on the chart.*)

On the 4th February, when in lat. 5° 50′ S., long. 84° E., she encountered a severe gale, with the wind at W.N.W. to N.W. The weather was exactly that peculiar to hurricanes, and the vessel was under treble-reefed topsails, running to the southward.

On the 5th, the gale had increased, "the squalls violent," there was constant rain and a heavy head sea. Some bulwarks were carried away and other damage sustained. The wind *west*, in lat. 8° 18′ S., long. 84° 1′ E. The barometer was at 29° 90′, and the sympiesometer 29° 25′.

Next day (6th February) as she continued to get to the southward, the wind was found more violent, and "the weather dark and stormy;" a heavy sea was running and breaking over the vessel. At 7 A.M. the ship was hove-to under close-reefed main-topsail and main-trysail." The wind was W.N.W. to W. by N., in lat.. 9° 45′ S., long. 84° 13′ E.

The barometer 29° 74′, sympiesometer 29° 12′. On the same day (6th February) the *Carnatic* was not far from this ship, being in lat. 11° 42′ S., long. 85° 5′ E. She was also lying-to with a storm from S.W. with even more violence, accompanied by "thick weather, heavy rain, and a tremendous sea running." The barometer on board of her was down to 29° 50′, and sympiesometer 29° 40′. The positions of these two vessels were in the northern half of the hurricane, the one most to the southward having the barometer lower than the other by 24′, and worse weather. The vortex in this early stage was, in all probability, moving along the ordinary path, about 12° or 13° S.

On 7th February, the *Earl of Hardwicke* ran south about 63 miles and was again hove-to in lat. 10° 48′ S., long. 84° 12′ E. The "gale blew in violent gusts, with constant rain." The main-topsail, although close-reefed, was obliged to be taken in. The wind veered from N.W. to N.N.W. in the twenty-four hours. The barometer 29° 58′, and the sympiesometer 28° 94′.

On the same day, the *Carnatic* was hove-to during the twenty-four hours, with tempestuous weather, and being about 50 miles further south than the *Earl of Hardwicke*, had a proportionately greater fall of the mercurial column, which was down to 29° 40′. The wind N.W.

From these circumstances we infer that the vortex of the gale was about 80 miles to the south-west of the latter. In fact, both vessels having rushed half-way to the centre, found it necessary to lie-to while it was passing.

On the 8th, the *Carnatic*, farthest to the S.W., attempted to scud, and after getting 70 miles nearer the gale, was again compelled to heave-to, under close-reefed main-topsail, with the usual kind of weather towards the centre of a storm. It was blowing at N.W., and the barometer down to 29° 35′. After lying-to, she found the weather moderate a little, and at noon her latitude was 13° 21′ S., long. 82° 50′ E. Barometer rising.

The *Earl of Hardwicke*, behind the *Carnatic*, finding the weather getting better, also set her topsails and steered S.W., with a "N.N.W. wind, squally, and a confused sea." Lat. 12° 52′, long. 82° 53′. The barometer up to 29° 77′.

Had the *Carnatic* continued to run after the storm, we should have had the same details in her log as in the storm of 1838. The ship remaining quiet on the 9th, the vortex moved away to the

S.W., and on the following day in lat. 14° 25′ S., long. 82° 21′ E., she found settled weather, and let out all reefs. The wind at *North.*

On the same day, the 9th, the *Earl of Hardwicke* running S.W. 144 miles, was in lat. 24° 20′ S., long. 81° 31′ E. A *North* wind veering to N.E. and a "heavy cross swell," but fine weather with passing showers.

The way in which these two ships met the gale is very similar to that of the *Ganges* and *Albion*, and by lying-to they were quickly out of it. The effect of running after the storm for sixty or seventy miles, in lowering the barometer, is well exemplified in the *Carnatic's* attempt to continue her voyage on the 8th. The veering of the gale from S.W. by N.W. to N.E. is simply explained by the relative positions of the vessels each day to a vortical storm moving along a track nearly the same as that laid down on the chart.

At Mauritius, while this storm was prevailing, there were strong S.E. winds, from the 6th to 12th February, when they veered to the south. On the 13th, 14th, and 15th, the weather was "wild, unsettled, and blustry." There was heavy rain, low stratified clouds driven along by the gale, and a high surf from the southward was thrown on the coast. The wind in the three days mentioned, veered round by S.S.E. to south and S.W. to N.W. On the 16th with the last wind there was much thunder and lightning, and a tremendous sea was breaking along the shore.

There seems to be little doubt but that this was the same storm passing the island; indeed it is recorded in our Register that "a hurricane is supposed to be passing." The time which it took to travel from 80° to the neighbourhood of Mauritius agrees exceedingly well with that of the Rodriguez gale.

Nor have we quite done with this hurricane. The *Carnatic*, after having got out of the first encounter as already described, continued her voyage with moderate weather till the 21st February. On this day she was in lat. 26° S., long. 58° E., when she ran into a storm, with the wind at

N.W., and had the usual weather and sea. Her course being W. by N. in the course of the 22nd, she had the wind veering to S.W., and was under closed-reefed topsails, thus, in our opinion, running across the north side of the same rotatory gale to which she had been exposed during its early and more rapid career.

THE "WINDSOR'S" STORM OF 1841.

(*No.* 6 *track on the chart.*)

On the 21st March, this ship got into a storm in lat. 11° 25′ S., long. 89° 45′ E. The wind was W.S.W. to S.S.W. as she advanced to the southward. "It blew with great violence in hard squalls, attended by incessant rain and violent lightning." The topsails were on the caps, and the courses stowed. At 5h. 30m. A.M., "heavy squalls, loud claps of thunder." "Hove-to under close-reefed main-topsail and main-trysail. At 8h. A.M., moderating, and soon after *almost calm*. Noon, set the topsails. A light breeze, cloudy, and variable. At 4h. P.M. the gale recommenced, with lightning and thunder, at S.E., in two reefs in the topsail, but by midnight all sail stowed and the vessel hove-to." The bar. 29·63, symp. 29·19.

On the 22nd, the same weather. Ship hove-to under close-reefed main-topsail and main-trysail. During twelve hours the wind was E.S.E., N.W., S.W., S.S.W., and S.E., but at noon the barometer was up to 29·75, the symp. 29·48, and the weather improving. Lat. 12° 32′ S., long. 89° 21′ E. In the afternoon she commenced running S.S.W. eight and nine miles an hour, and had the wind S.E. veering to E.S.E.

On the 23rd, she got as far south as lat. 14° 46′ S., long. 86° 26′ E., and although the wind from S.E. was squally and stormy, the weather was getting much better. Bar. 29·85, symp 29·58.

This has all the distinguishing points of a rotatory gale, but the vortex was either moving slowly or in an irregular manner, as Colonel Reid thinks was the case in the *Albion* storm, else the winds have been incorrectly recorded in the log. The first supposition is very probable, and is supported by cases which will be brought forward further on in this inquiry. The rotating and progressive characters are obvious enough.

The *Windsor* ran well to the southward, and carried a fine S.E. trade with her till the 2nd April, when, in lat. 26° S., and long. 58° E., the wind was found veering to E. by N. The bar. 30·00, symp. 29·65, ther. 82°.

On the 3rd April, continuing her course W. and W.S.W, she had the wind veering, in the twenty-four hours, from N.E. to N.N.E., north, and N.W. The barometer 29·90, sympiesometer 29·50. It blew a "heavy gale," accompanied by "thunder and lightning." There were "constant squalls and rain," and a huge high sea running. The ship under close-reefed topsails. Lat. 26° 55′ S., long. 55° 57′ E.

On the following day, with the same weather, and a "*heavy confused swell*," this ship was steering S.W. for a few hours, but afterwards N.N.W. and N.W. She had the wind W.N.W. west, W.S.W. and S.W. at noon, in lat. 28° 39′, long. 54° 29′ E. The barometer at one time was down to 29·76, the sympiesometer 29·66, and thermometer 76°. The weather moderated towards the end of the twenty-four hours, and next day the gale was over.

On this second occasion, we find, in the space of forty-eight hours, a ship, in running over a distance of 240 miles, about two points to the southward of west, has the wind *gradually* changing from N.E. to N.W. and S.W. through all the intermediate points, and the barometer falling in the same manner. After studying the Rodriguez storm, it leads to the inference, that, during the period in question, this ship was traversing the northern segment of a rotatory storm.

If we also count the number of days that the hurricane just referred to, took to travel from 80° to 56° E. long., it will be found to correspond closely with the successive appearance of the *Windsor's* storms of 1836 and 1838 in the same latitude. The state of the weather at Mauritius, about the beginning of April, was such as to create a suspicion that a hurricane was passing, and a very heavy swell from the southward was thrown on the coast for three days. May we not conclude that this was the same storm throughout? If so, the early stages of progression were rapid, and the latter, when beyond the tropic, so slow as to allow of the *Windsor* overtaking it.

THE "SERINGAPATAM'S" STORM OF 1842.

(*No. 7 track on the chart.*)

From this vessel's log we obtain information regarding another of those tempests first discovered about 10° S. and 90° E., moving to the S.W. It is proposed to trace its appearance at different points along the ordinary track, as laid down on the chart.

On the 29th January, the *Seringapatam* encountered a severe gale in lat. 11° 48′ S., long. 81° 57′ E. Although limited in space we will give the log, abbreviated of the unnecessary details.

Extracts from the Log of the ship SERINGAPATAM.

Hour	K.	F.	Courses.	Winds.	Bar.	Remarks.
						29th January. 1842. A heavy gale, ship running under close-reefed topsails. Hard squalls, constant rain, and a heavy sea. At midnight, hove-to. Ship labouring heavily, and making much water. Confused sea at 7 A.M. Vivid lightning to N.W. Lat. 11° 48′ S., long. 81° 57′ E.
P.M.						
1			S.W.	S.E.	29·58	
9				S.S.E	Symp.	
A.M.						
1	1		„	Variable	29·48	
5	1	4	W.S.W.	South.	Bar.	
8	1	4	W.N.W.	S.W.	29·63	
						30th January. Very threatening, with incessant heavy rain. Barometer falling. Ship labouring excessively and shipping much water. At 6 A.M. set close-reefed fore and main-topsails and tried to scud, but found she shipped so much water that we were obliged to heave-to under close-reefed main topsail and main-trysail. Lat. 12° 48′ S., long. 81° 7′ E.
P.M.						
1	4	4	South.	W.S.W.		
2	4		S.S.W.			
4	4		S.W.	South.		
8	1		Hove-to.			
A.M.						
1	1		West to	North.	29·45	
4	1		S.W.			
8	6		W.S.W.	N.N.E.	29·50	
9	8					
10	8					
11	8					
12			Hove-to.			
						31st January. A hard gale, with heavy squalls, and constant rain.
P.M.						
1	1	4	Hove to. N.W.	N.N.E.	29·38	

Extracts from the Log of the SERINGAPATAM (*continued*).

Hour.	K.	F.	Courses.	Wind.	Bar.	Remarks.
A. M.			N.W.		29·60	31st January—*continued.* Ship hove-to the whole 24 hours, the gale blowing heavily and shipping much water. Six A.M. moderating. Lat. 13° 10′ S., long. 80° 45′ E.
			S.W. 160 miles	Northerly	29·69	1st February. Heavy squalls, raining heavily, and a confused sea running. Barometer rising slowly. Lat. 15° 8′ S., long. 78° 51′ E.
			SW.byW 124 miles	North. N.N.W.	29·84	2nd February. Weather moderating. Latterly light winds, ship rolling heavily. Lat. 16° S., long. 77° E.
P.M. A.M.			S.W. „ 78 miles	E.N.E. Calm.	29·94	3rd February. Fine weather, but a confused sea. Lat. 16° S., long. 76° E.

In this storm, evidently of a rotatory kind, the ship to whose log we refer, must have run in front of the vortex, having the wind S.S.E, and experienced the usual calm of a few hours, followed by the tempest from another quarter with all its former violence. While lying-to, the vortex passed over her, and the wind veered from S.S.E. to S, S.W., west, N.W., and ended at north. On the 3rd, when the barometer was rising, she commenced to run directly after the storm, but again found the weather so bad as to compel her to heave-to, and the mercury descended from 29·50 to 29·38. She then lies-to for twenty-four hours, and it is moderating. The next three days she runs after the storm, but gradually drops behind it, and the weather becomes fine; yet the heavy swell left by the gale is still felt. Every fact in this case is reconcilable with a moving vortex near which the maximum depression of the mercurial column existed. The diurnal advance of the storm was such as to leave the *Seringapatam* behind, even at the rate she was sailing.

In accordance with the laws which direct revolving gales along certain paths, there are strong indications of this one having embraced the island of Mauritius in one of its sides while passing to the S.W.

At *Mauritius*, on the 1st, 2nd, and 3rd February, when the *Seringapatam* had N.N.W. and north winds, it was blowing from S.E., " fine cool trades, with a clear sky and beautiful sunsets." On the 5th and 6th, the wind was S.W., N.W., and west, light calms and oppressive. Barometer 29·80 to 29 90.

On the 7th, 8th, and 9th, the weather was " wild, unsettled, and sultry, and the atmosphere dark, cloudy, and wet." " Heavy rain" and a "great deal of thunder," with the wind at south to S.W., blowing fresh and in squalls. Barometer at 29 70. A high sea breaking on the coast.

On the 10th, the wind S.W. to N.W., accompanied by " much rain and thunder. A heavy swell from south." Barometer 29·60.

On the 11th, the same weather, and wind N.W., " squally," and the high surf along the coast. Barometer 29·80. From this time, however, it began to improve, and in two days more the weather was settled.

On this occasion, we believe, that the state of the barometer, and other circumstances, created a suspicion at Port Louis that a hurricane was approaching, and every preparation was made for it by the shipping in the harbour.

But to return to the *Seringapatam*. It appears by the log of this ship that she had fine weather from the position in which we left her, as far as lat. 25° 26′ S., long. 58° 1′ E., where she found the trade wind veering to N.N.E., north and N.E., and encountered a strong S.W. swell.

Next day, 12th February, the wind was E.N.E. to N.N.W., with thick hazy atmosphere, and a sultry oppressive feeling. It was squally and blowing strong. Lat. 25° 26′ S., long. 56° 34′.

On the 13th, the wind N.E., north, and N.W. A strong gale, "hard squalls, constant heavy rain," and much "vivid lightning and thunder." The vessel was under close-reefed topsails, and had some canvass carried away. Lat. 27° 5′ S., long. 53° 31′ E. Course 203 miles west.

On the 14th, the wind still veering to S.W. and S.S.W. In the space of the twenty-four hours the course was N.W. 124 miles. The weather was found to be getting much better, and the reefs were let out of the topsails. Lat. 27° 5′, long. 51° 23′ E. "A confused swell."

Here again is a vessel, about fourteen days after encountering a storm, at one part of the hurricane track, getting into the north side of the same gale near its termination, and where there is reason to suppose that its progressive motion is exceedingly slow. This ship steered a course nearly true west for 330 miles, the wind changing in forty-eight hours from N.E. to N.W. and S.W., gradually increasing to a gale near the middle of the space which she traversed, and then moderating as she ran N.W. (nearly W.N.W.) Her course would intersect the northern side of the stormy circle.

THE "SIAM'S" STORM OF 1844.

(No. 8 track on the chart.)

When these pages were sent to press, the storm encountered by the *Prince of Wales** was traced out from the log-book of this vessel alone, but, through the kindness of Sir John Marshall, extracts from the log of the ship *Siam*, in the same hurricane, have been placed at our disposal, which enable us to throw some additional light on the subject. The case of the former was adduced as a proof of vortical storms being often encountered by vessels when leaving the N.W. monsoon, in running south to get into the S.E. trade. By the information just received, it will be seen that the *Siam* was sailing through the trade-wind to the northward, and advancing, almost on the same meridian, to meet the *Prince of Wales;* both, in accordance with what has been advanced in the following pages, finding the weather increasing to a tempestuous degree as they approached the contiguous borders of these two great winds. But besides this, the *Siam's* log is especially interesting, because it is the only one which we have been able to obtain of a vessel, on her way to India, meeting in with a hurricane. So very late has this new matter been obtained, that the central track of the storm, as calculated from the *Prince of Wales's* log alone, cannot be altered on the chart, but this is of no importance, as it does not affect the direction of the storm's progress, merely leading us to suppose that the diameter was somewhat greater, and the focus rather more to the southward, than appeared to be the case by the inspection of one log, unaccompanied by barometrical observations.

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* One of the splendid new ships belonging to Messrs. Green & Co.

On the 27th March, 1844.—The ship *Prince of Wales* was in lat. 9° 8′ S., long. 84° 28′ E., with a S.W. and southerly gale, blowing strong and "in squalls," accompanied by very heavy rain. She was running as much to the southward as the wind would permit.

On the 29th March.—The same vessel had a *westerly* wind, blowing "a strong gale, with gloomy unsettled weather, much rain, and a tremendous head sea," causing the ship to pitch bows under. Was steering S.S.W., and under double-reefed topsails. Lat. 12° 4′ S., long. 84° 46′ E.

On this day, the *Siam* had an *east* wind, "strong breezes and fine," but "increasing and cloudy." Taking in studding sails. At noon, in lat. 23° 2′ S., long. 84° E. Barometer, 29·95. Sympiesometer, 29·78.

30th March.—The *Prince of Wales* found the gale increasing, with the wind veering to N.W. Had three reefs in the topsails, the royal and mizen top-gallant masts sent down. At 4 P.M., hove-to under close-reefed main-topsail, and had "heavy squalls with rain at the time." At 11 P.M., re-commenced running S.W., but by 4 A.M. was again obliged to heave-to. "A heavy *confused* swell, the ship labouring and shipping a great deal of water." At 9 A.M. was again scudding S.W., and at noon was in lat. 13° 8′ S., long. 83° 57′ E.

The *Siam* had been steering N. ½ E. during the twenty-four hours, with a strong and increasing wind at *east*. She gradually began to feel a "heavy cross sea," and the ship was "labouring much," had the "breeze freshening," and was taking in canvass, so that by noon there were two reefs in the topsails. Lat. 19° 51′, long. 83° 36′, almost due south of the *Prince of Wales*, and only about 400 miles apart. The barometer 29·70, sympiesometer 29·56.

On the 31*st March.*—The *Prince of Wales* continued running S.W. before the gale nearly all day, till 8 A.M., when its increasing violence compelled her to heave-to for the third time, with the wind veering from N.W. to N.N.W and north. A confused sea was running, and the vessel labouring very heavily. At noon, in lat. 14 57 S., long. 82° 13′ E., this ship was evidently near the borders of the monsoon; and from the *Siam* we shall find that she also had the weather increasing to a tempest near the opposite limit of the trade-wind.

During the same twenty-four hours, the *Siam* was steering N. by E., at the rate of seven and eight miles an hour, and the distance run, as per log, amounted to 171 miles, by which we calculate that her position at noon was about lat. 17° S., and, owing to magnetic variation and a little lee-way, in long. 83° W. It would seem that she was on the south side of the vortex, while the *Prince of Wales* was opposite, and only 120 miles off, with the focus between them. While traversing the distance mentioned, the violence of the wind and sea were regularly increasing, and brought her under close-reefed topsails. It is called a "strong gale and a tremendous sea." The wind was "*east* to E.S.E." the whole time. Barometer 29·10, sympiesometer 28·90, thermometer 82°.

On the 1*st April.*—The *Siam*, continued running E. by N. for 20 miles more, when the weather became so terrific that she was hove-to, and must have been about lat. 16° 40′ S., with the wind at E.S.E. It is important to know this, as for the next forty-eight hours all knowledge of the winds or courses are wanting. The state of the weather, however, may be gathered from the following literal extracts from her log for this day. "At 5 P.M. blowing a complete hurricane, the sea making a breach over the ship. At 8 P.M., shipping tremendous seas over all, which took the long-boat over the side, and galley and everything off the deck. At 9-10 P.M. shipped a tremendous sea, which stove in the front of the poop-cabins, washed away the quarter-boats, binnacle, skylights, and two seamen. At 10 P.M. the fore-topmast was blown away, the fore-topsail-yard and fore-yard came down on deck. Finding the lower deck half full of water, and everything below adrift and washing about, and so much water on deck that the hands could not stop at the pumps, cut away the main-mast to save the ship; and the mizen-mast went after it. Still blowing with tremendous fury; the ship was some time before she righted, and, having no binnacle, could not tell how she was going, or which way the wind was. At midnight, wind more moderate, but the sea making a complete breach over the ship. All hands lashed to the pumps. — A.M., the weather moderating, but a heavy sea running, and the ship labouring and rolling. Sun obscure."

On this day, the *Prince of Wales* lay-to till 5 P.M., when she again bore up, and steered so much to the southward as only to make 13 miles of westing, and at noon was in lat. 16° S., long. 82° E., with the wind at N.E. and weather more moderate.

On the 2nd April.—The *Siam* was behind the gale, and at noon found herself in lat. 18° 24′ S., long. 83° 46′ E. A light wind at S.S.W., and fine weather but cloudy. A heavy S.W. swell continued.

The *Prince of Wales* was in lat. 16° 44′ S., long. 81° 5′ E., almost calm, or a slight S.E. breeze, and a "long swell from S.W."

In this hurricane the vortex would appear to have been moving to the S.W., in the interval between the two adverse winds. The *Prince of Wales* encounters it on the equatorial side, and, by following it, has the gale lasting from the 27th March till the 1st April, with the wind veering from south by west, to N.W. and N.E. Three times she attempted to scud S.W. in the wake of the vortex, and was as often compelled to lie-to. On the 31st it is termed a "moderate gale," but after running S.W. for eight hours, the violence was such as to oblige her to heave-to. When her course was changed to south, and consequently diverging from the path of the storm, the weather was found to be better. In fact, by being behind the vortex, every time that she lay-to was marked by an improvement in the weather.

Now, with the *Siam,* nearly in front of the vortex, and running N. by E., almost directly to meet it, the consequences of heaving-to were very different; for, by this proceeding, the whole fury of the tempest passed over or very near her. It is also remarkable that this ship had the violence of the hurricane over in forty-eight hours, owing, no doubt, to her course being in a contrary direction to that of its progression. Although, for reasons given in the log, it was impossible to ascertain the veering of the wind and movements of the *Siam*, yet, from the information derived from the *Prince of Wales* of the course of the vortex, we may infer that it passed between these two ships on the 31st, and, in conformity with other storms, was moving nearly S.W. The last wind mentioned in the *Siam's* log on getting into the vortex is E.S.E., showing that she was almost in front of it, and most probably this veered by N.E. to N.W. That she experienced such winds is obvious from the fact of her having been carried 130 or 140 miles to the southward, between the 31st March and 2nd April, and this is rendered still more probable by the north and N.E. winds, which prevailed near the *Prince of Wales's* position.

STORMS OF 1843.

Under this head, it is intended to trace a rapid succession of "stormy gyrations" which occurred in the South Indian ocean during the period of the year peculiar to such commotions. The subject is one of great interest, as it tends to exhibit the condition of the atmospheric currents before and after the Rodriguez hurricane of this year. The season in question appears to have been prolific in tempests. It is true, some of these, as far as our knowledge extends, seem not to have been remarkable for extreme violence, or rather were not followed by those calamities which force them more strongly on our notice. But their relative position to each other, as to season and locality, gives them importance.

There are certain localities in the Indian Ocean south of the equator in which, during the solstitial season, causes seem to exist, almost of a permanent nature, which keep up a continued turbulence of the atmospheric current near the inner border of the S.E. trade wind, and adjacent limits of the westerly monsoon. In fact, that masses of air of a greater or less extent acquire a vortical motion of different degrees of violence, but all tending to drift to the south-westward, and so closely following one another as never to leave a long interval of equable weather or steady winds. In looking over a Meteorological Journal, kept at Port Louis, in Mauritius, from Nov. 1842 to May 1843, it is very observable that the winds passed through a series of almost regular changes, each of which nearly described a complete circuit in from ten to twelve or fifteen days; and this is even more remarkable from the prevalence of south-east and southerly breezes, varying only a few points during the rest of the year. The same tendency to gyrations of the winds exists during every summer and autumn, and the year 1843 is only referred to as an example. After calms or light winds, with occasional thunder storms from N.W., the trade-wind set in with a force increasing to a tempestuous degree, and gradually veered to N.E., north, and N.W., in one direction, or by south to S.W. and N.W. in the other; the latter mode of revolution being by far the more common. In both cases, a little before the wind began to blow from the westward, heavy rain, and occasional thunder, were the ordinary precursors of the change. If we admit that a succession of vortices like that of the Rodriguez gale, were following one another, it would at once explain the veering of the wind, and state of the barometer.

At *Mauritius*, on the 16th and 17th January, it blew a strong gale from S.E., with a rapid scud overhead and a heavy fall of rain. The barometer fell from 30 to 29·88. On the 18th the gale increased, with all the appearance of a hurricane coming on. The wind was veering from S.E. to S.S.E. At 10 P.M. the barometer was 29·74. At 2 A.M. on the 19th it was 29·60; at 6 A.M., 29·44; at 8 A.M. 29·65; at noon, 29·80, and continuing to rise. During the night the wind, blowing violently in heavy gusts, doing some injury to trees and buildings, and was accompanied by much rain, veered gradually to south, S.W., west, and was N.W. next morning, and continued strong during the greater part of the day. The ships in harbour were all prepared for a hurricane. Nor can any one doubt that this was the margin of a revolving storm impinging upon the island, while the focus was passing 100 or 150 miles to the eastward.

THE "MADAGASCAR'S" STORM, 1843.

(*No.* 9 *track on the chart.*)

On the 26th February, in lat. 9° 26′ S, long. 83° 28′ E., the *Earl of Hardwicke,* got entangled in a gale at south to S.E., accompanied by "severe squalls, constant rain, vivid lightning, and a heavy cross sea," and was under close-reefed topsails. She had the same weather till the 28th, when, in lat. 11° 48′ S., long. 80° 20′ E., as she ran to the southward it began to get better, and merely felt the confused swell which is thrown for many hundred miles on both sides of the path of a hurricane.

On the 27th February, the *Madagascar,* nearly in the same latitude and longitude as the *Earl of Hardwicke,* had similar weather and a "heavy confused swell.

On the 28th February, the same ship was in lat. 14° 13′ S., long. 79° 35′ E., the wind at S.S.E., the barometer 29·80. A heavy S.W. swell was felt, causing the vessel to "roll, labour, and ship seas." She was under double-reefed topsails. It is a curious coincidence that on this day, and nearly in the same latitude, the *Magnasha,* in long. 115° E., was involved in a most severe hurricane (see page 118).

This storm seems to have passed Mauritius, where it blew a fresh gale at S.E. from the 1st to 4th March, and the barometer fell to 29·80; the wind changing to N.E. and N.W. on the night of the 4th and morning of the 5th, and it was "tempestuous," accompanied by much rain. The wind continued at N.W., west, and S.W. for four days, when the atmosphere became clear.

On the 1st March, the *Madagascar* was in lat. 16° 56′, long. 76° 47′, the wind S.E., and barometer 30. On 8th March, when in lat. 29° 27′ S., long. 52° E., the *Madagascar* again encountered a "heavy cross sea," a strong gale veering from N.E. to N.W., S.W., and west. The barometer fell to 29·80. The weather threatening and attended by vivid lightning and thunder. The ship was under reefed topsails. Next day the wind was south, and barometer 30.

If this was a moving vortex, and pursued the same track as that which the Rodriguez storm did a month afterwards, we can understand how the *Madagascar,* after being in front of it in lat. 11° S., long. 80° E., was enabled, like the *Earl of Hardwicke,* to keep out of its way by running to the southward. On the 28th, she again felt its proximity. It most likely passed her to the west, from the indications at Mauritius, and afterwards by its slow progress to the south-west, she overtook it.

THE "VERNON'S" STORM, 1843.

(*No.* 10 *track on the chart.*)

It is remarkable to find that, while there is evidence of one gale of a progressive and vortical character exhausting itself near the termination of the common track, we discover another appearing at the N.E. end of the same route.

On the 2nd March, the *Vernon,* in lat. 8° 43′ S., long. 87° 23′ E., had the wind west to S.W., blowing a gale, "squally, with heavy constant rain, and threatening appearance of the weather." Three reefs in the topsails. Barometer 29·90, sympiesometer 29·60. Next day's log indicates better weather.

On the 4th, still in the westerly monsoon, the wind blowing in squalls, and a heavy swell from S.W. lat. 9° 42′ S., long. 86° 33′ E. On the 5th, found the wind veering to N.E.: constant rain and high sea. Barometer 29·80, sympiesometer 29·48, both falling. Lat. 11° 2′ S., long. 86° 21′ E.

Extracts from the Log of the VERNON.

Hour.	K.	F.	Course.	Winds.	Bar.	Remarks.
A.M.						March 6th. 1843.
2	8	4	S.W.	N.E.	29·48	A strong gale; squally with vivid lightning and heavy rain. Thick cloudy weather. Main-topsail close-reefed. Sent down royal and top-gallant yards, and housed the top-gallant masts. Hatches battened down. 5 A.M., wind round to south. Hove-to under main trysail.
4	8	4	„	„		
6	8	4	„	South		
8	1		West	S.W.		
10	2		North	West		
12	1		„	„	29·80	
P.M.						P.M. Strong gales. A tremendous high sea. Ship rolling heavily and taking in water over all. Afternoon, it began to moderate.
1			S.W.	N.W.	Symp. 29·53	
			hove to			Lat. 12° 26′ S., long. 84° 51′.

Next day, the 7th, was more moderate, but the weather still thick, and it was raining a great deal. Occasional heavy squalls, and the sea running high and cross. Wind N.W. to north, and N.E. Lat. 13° 44′ S., long. 82° 26′ E.

On the 8th, fine weather, and wind at S.S.E.

This has all the features of a rotatory gale moving to S.W., and occurring on the borders of the two great winds. The *Vernon*, while running on the 6th, evidently crossed in front of the vortex, with the wind from N.E., to south; and then lying-to with her head in the proper direction, to westward and northward, she soon dropped round its N.W. side. Three weeks after this, the Rodriguez hurricane was commencing in the very same place.

At *Port Louis*, from 8th to 12th March, a fine S.E. trade was blowing. From the 13th to 15th it increased to a strong breeze, and began veering to E.N.E., then to S.E. and south. On the 16th it was a heavy gale, with much rain, from S.W., veering to N.W., and continued so for a day or two. The barometer down to 29·70. The situation of Port Louis, at the leeward side of the island, is not favourable for observing the state of the sea when storms are near it, unless, which is very rare, they pass to the westward. Was this the *Vernon* storm impinging on the island? It looks like it, and the time which it must have taken to travel from 80° E. to the neighbourhood of the Mauritius corresponds with the rate of progression of other storms.

About the same time that the Rodriguez storm, the next in succession during 1843, but already given, was closing its career beyond the tropic, a disturbance of the winds not very dissimilar appears to have existed about lat. 9° or 10° S. and long. 90° E.

THE "HANNAH'S" STORM, 1843.

(*No.* 11 *track on the chart.*)

When in lat. 9° 41′ S., long. 86° 48′ E., on the 12th April, the *Windsor* encountered a fresh gale at S.E., with a "long southerly swell causing her to pitch heavily. There were heavy squalls and constant rain. She was under low canvass and steering S.W."

It would appear that on this occasion the *Windsor* was in the front of a progressive circular storm, as *five days* after the *Walmer Castle*, in almost the same situation, lat. 9° S. and long. 84° E. had the wind at N.W. to N.E., moderate and fine, and most probably arrived just as the storm was over.

On the 13th April the *Windsor*, in lat. 11° 45′, long. 84° 9′ E., had the same wind, S.E. "Squalls in quick succession, accompanied by gloomy weather, heavy rain, and a long swell."

The same ship had almost similar wind and weather to the 16th April, when, in lat. 18° 30′, long. 75° 55′, the wind was at east and E.S.E.; squally, with rain.

On the same day the *Hannah*, a little more to the northward, experienced fresh gales at S.E., and a heavy swell. Lat. 11° S., long. 78°.

On the 17th the *Hannah*, although steering S.W. by S. 130 miles in twenty-four hours, had the gale S.E., increasing, till it was almost a hurricane, with a tremendous high cross sea. Lat. 13° S., long. 77° E. Bar. 29·78. The *Windsor* had it more moderate, at E.S.E.; and the *Walmer Castle*, lat. 9° S., long. 84° E., had a N.W. and N.E. wind and fine weather.

The *Hannah* had the same weather and wind as she ran S.W. till the 19th. When in lat. 14° S., long. 71° 46′ E. it moderated.

In connexion with this gale we may mention the state of the atmosphere at Mauritius. After the N.W. winds which followed the Rodriguez storm had subsided at Port Louis, the S.E. trade resumed its sway, and blew with great steadiness from 14th to 18th April, when it began to increase in violence, accompanied by "squalls, rain, and low stratified clouds; and a hurricane was feared." On the 20th, the wind veered to S.S.E. and south, with a good deal of thunder and lightning accompanying it. On the same day, the *Windsor*, in lat. 24° 34′ S., long. 63° 21′ E., had an E.S.E. wind, and thick weather.

On the 21st, at Port Louis, the wind was round to S.W. and N.W., and continued so till the 23rd. The barometer only fell 20°.

The *Windsor*, on the same day, in lat. 25° S., long. 60° E. had the wind south; "a gale, drizzling rain, and squally."

The *Walmer Castle*, on 30th April, was in lat. 26° 28′ S., long. 56° 50′ E., when she again got into a severe storm, and was under close reefed topsails, with the wind N.E., veering to N. and N.W., attended by "rain, lightning, and heavy squalls. A high N.W. swell."

On 1st May she carried the same kind of weather to lat. 26° 30′, long. 55° 38′ E., but the wind changed from N.W. to S.W.

On the 2nd, in lat. 26° S., long. 54° E., it was a moderate south wind, but a heavy westerly swell remained.

These coinciding circumstances, supported by analogy, are almost conclusive with regard to this having been a regular progressive whirlwind, like the Rodriguez storm, and its movement so tardy as to enable the *Walmer Castle* to come up with it in 26° S. The *Hannah* and *Windsor*, when involved in it to the N.E. of Rodriguez, by keeping well south, got out of it, in the same manner as the *Blanche* and *Sea Queen*, but did not again come up with it.

THE "ARTEMISE'S" STORM, 1843.

(*No.* 12 *track on the chart.*)

At the very moment when a storm was blowing near Mauritius, another, and by its effects a more violent one, was raging off Java Head at the very easternmost extremity of what seems to be their ordinary track. We regret that the details are exceedingly incomplete, and being collected from a single ship, they are not of any importance in affording data to trace out the path and rate of progression of the vortex with any precision. Nevertheless, they furnish ample evidence of the rotatory character of the gale, its violence, and the situation where it took place.

The information regarding this hurricane is derived from the log of the Swedish bark *Artemise*, which put into Port Louis about the time we were leaving it. It was even with difficulty that we could obtain as much of the log as that which is given below. The extracts are translations from the Swedish language by Captain Sfunggeren, in command of the vessel.

Extracts from the Log of the ARTEMISE.

Hour.	K.	F.	Course.	Wind.	Bar.	Remarks.
A.M.						24th April, 1843.
1	8	4		N.E.	30·44	Strong. Double-reefed topsails.
2	7					
3	7	4				
4	7	4				Thick, dark, gloomy weather.
5	4					
6	1	4				Lay-to under main-topsail, close-reefed.
9			Hove-to. N.W.	SW.byW	30·33	
12					30·20	Under bare poles. Ship's head North.
P.M.						
9					29·98	Thick dark atmosphere.
12					29·78	Lat. 10 S., long. 106 E.

On the subsequent days the log contains the following brief remarks:—

25th April.—At 2 P.M., wind shifted from N.E. to S.W., a small squall at the time. About midnight a hard squall; the wind then shifted to N.E. and E.N.E.,—ship lying on her beam-ends. A.M., ditto wind and weather. Bar. 27.30 at midnight, and 27.40 at 9 A.M.

On the 26th.—Blowing very hard—a regular hurricane, with thick dark atmosphere. Ship's head to the westward, driving S.W. At 4 A.M., wind shifted to the south. At 5, all three topmasts went with the head of the mainmast. Foreyard went overboard. Bar. 27.80.

27th.—At 1 P.M., the wind again shifted round by the southward to the eastward, blowing hard with a heavy high sea. Ship labouring hard. Bar. 29.20. A.M., the wind a little more moderate, and continued decreasing. The bar. 30.4.—Clearing the wreck.

The above notes are very imperfect, and give a confused idea of the ship's position, and the veering of the wind; but they clearly show that the latter was round to every point of the compass. As the ship seems to have been hove-to on the 24th, and remained near the vortex so long, it would lead to the supposition that the latter was almost stationary, or whirling about without any decided course; but it is not improbable that the vessel was running before the wind, and consequently thus exposed herself to so many changes in the direction of the storm. We are led to this conclusion from the fact of the tempest beginning to abate immediately after the topmasts were carried away, and she could not run. This is a circumstance so common to other vessels, and followed by the same consequences, that we must attach some importance to it. Had our stay been longer at Mauritius, we should have taken pains to get some more complete account in this, as in other cases. Such, however, as the facts are, they are worthy of notice in pointing out a situation where severe hurricanes may be met in with.

Two other equally severe tempests, near the N.W.

coast of New Holland, belong to 1843, but will be mentioned further on.

The storms already referred to are those that have been experienced near to what may be considered as their source, the space intervening between the westerly monsoon and S.E. trade, and subsequently assumed a progressive motion to the W.S.W. and S.W., passing near Mauritius and Rodriguez. We may now direct attention to such as have been felt at other points along their common track across the Indian Ocean.

THE "CULLODEN'S" STORM OF 1808.*

(*No.* 13 *track on the chart.*)

The details of this disastrous gale are so fully given by Colonel Reid, that but for one or two points it would be unnecessary to advert to it now, except as a concurrent proof of the general character which distinguishes rotatory gales in the neighbourhood of the Mauritius.

As in the case of the Rodriguez storm, the *Culloden* and her convoy first perceived signs of the coming tempest as far to the N.E. of Rodriguez as lat. 18° S., long. 79° E., and on the 8th March appear to have been sailing on the southern edge of the circle. It was not till six days after, when about lat. 22° S., and long. 62° E., that they got entangled in the more severe part of the gale. On the 14th, in lat. 22° 54′ S., long. 62° 14′ E., the *Culloden* must have had the vortex to the N.E. of her.

On the 15th, there appears to be some mistake in the latitude of the *Culloden*, which is put down 22° 54′, the same to a mile as on the previous day. Now it appears by her log, that from noon on the 14th to the same period on the 15th, she ran about 188 miles W. by S., and a part of the time W.S.W., which, with upwards of one point of westerly variation, would give the true course W.S.W., at least; consequently, her position must have been much more to the southward and less to the westward, than that laid down on the

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* "Law of Storms," by Colonel Reid.

Chart No. 8.* This is a discrepancy of some importance in the present case, because the *Culloden's* log, and her true place on the 15th, are the only means of fixing the apparent position of the vortex, and the direction of its progress, both before and after, as well as on this day.

On the 16th, in lat. 26° 6′ S., long. 56° 37′ E., the *Culloden* was lying-to, with the storm blowing E. by N. to N.E., showing that its centre was passing to the N.W. and west of her. The winds and position of the *Huddart, Nereide,* and *Terpsichore,* satisfactorily prove this.

On the 17th, the *Culloden* had run to the S.W., and was in lat. 26° 53′, long. 54° 42′ E., again "lying-to" near the vortex with the wind veering N.N.E., north, N.W., W.N.W., still showing its course unchanged, and proceeding S.W. by S., or S.S.W. The *Huddart,* in lat. 25° 34′ S., long. 60 E., had the gale N.N.E. to N.N.W., and next day N.W. The *Northumberland,* in lat. 26° S., long. 57° 26′ E., had a N.E. to N.N.W. wind, and N.W. next day. All these agree in proving the centre of the gale to have been S.W. of them.

It is inferred by Colonel Reid that on this and the subsequent day this storm suddenly recurved, and drifted off to the S.E. Much as we regret to differ with the able author of the "Law of Storms," we cannot help thinking that this recurvation of the *Culloden* storm is not made out in a decisive manner. The only evidence adduced in support of this opinion is the circumstance of the *Racehorse,* 600 miles to the S.E. of the place where the vortex is clearly ascertained to have been on the 17th, encountering stormy weather of a rotatory kind on the 18th. As the fact of the Mauritius storms turning to the S.E. is a point of much practical importance, it is one that merits the closest inquiry.

Had the vortex moved from its position on the 17th to that of the *Racehorse* on the 18th, it must have passed almost directly over the *Nereide* a second time. But it appears that this vessel in lat. 26° 46′, long. 58° 16′, had "moderate and cloudy weather" from the 17th P.M. to 18th, and was repairing damages. The *Northumberland* and others, in lat. 25° 45′ S., long. 56° 44′ E., had

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* Law of Storms.

N.W. winds on the 18th. Now, on the 17th, when the centre of the hurricane was about lat. 27° S., long 56° E., the *Racehorse* was in lat. 33° 44′ S., long. 62° 30′ E., with light winds from east to south. If, therefore, the gale which she felt on the 18th was the same as that of the *Culloden* fleet, the centre must have been transported 600 miles in twenty-four hours, a rate of progression nearly three times greater than that of other storms in the Indian ocean during their most rapid motions. In every case which has been examined, the diurnal advance of the vortex seems to be very slow near the tropics. In the present instance, its progression was so tardy that vessels, when scudding, overtook it, as in the Rodriguez and other hurricanes.

The gale which the *Racehorse* experienced on the 18th has more the appearance of having come from N.E. than from N.W., that is, if the direction of its rotation was conformable to all others in the southern tropic. Thus the winds, on the 18th and 19th, were south, S.S.E., S.E. by S., E. by S., E.N.E., ending in a moderate breeze when she was in lat. 31° 26′ S., long. 62° 48′ E. Had the storm come from the place it was in on the 17th, it must have begun at N.E. and ended at S.W. Besides, as in other cases, a single ship is hardly sufficient to trace a rotatory gale without other concurring circumstances. Of course we are not prepared to say that hurricanes in the South Indian Ocean do not turn to the S.E., but merely suspend our opinion till some more decided proofs are obtained. Vessels coming to the Mauritius from the Cape usually run down their easting in lat. 32° and 34° S., and when in the meridian of 60° E., they steer due north, consequently, if hurricanes recurved in the direction supposed by Colonel Reid, there would be a double risk of their encountering them. On the contrary, it is well known that although experiencing the usual gales in south latitudes, they very rarely meet with a hurricane.

Theory, and the analogy of West India storms, render it probable that they may occasionally turn to the S.E., but as hitherto it has been found that all distinct traces of their course are lost at the ordinary limit of the trade wind in lat. 28° and 30° S., it would seem that beyond this they no longer preserve their specific action. On the breaking up of such a vast whirlwind, stormy commotions of the atmosphere around its termination must be expected. The course of the *Culloden* storm might easily be explained by the diagrams of that of Rodriguez, so very nearly do all great hurricanes follow one another.

THE "BLENHEIM'S" STORM OF 1807.*

(*No.* 14 *track on the chart.*)

The account of this gale, in the "Law of Storms," although confined to the information derived from the log of one vessel, is very interesting and instructive. The course which it seems to have pursued is nearly that of the Rodriguez and *Culloden* storms when near Mauritius, but a little to the eastward of the former by 40 or 50 miles. So little difference, however, except from anachronism, exists, that the diagrams given in the explanation of one are almost equally applicable to the other. The *Harrier* began to feel the gale several hundred miles to the N.E. of Rodriguez, with a wind veering to N.E., at all times a suspicious sign in that neighbourhood. Judging from the relative position of the vortex to the *Harrier* on the 1st and 2nd February, its progression does not appear to have been much more than 100 or 120 miles a day, nearly that of other storms in the same latitude, and this is confirmed by the fact of the ship in question having been able to scud with the wind N.E. parallel to its course, and even get in front of and cross its path, without being overtaken by it.

On the night of the 1st she seems to have run N.N.W. for 50 miles, almost directly to meet the approaching focus, and, as might be expected, found the "gale increased to a hurricane." In the course of the 2nd February, the *Harrier*, with the wind veering S.S.E. to S.E., south, W.S.W. and west, kept before the gale to the north-west and north, by which she soon got clear of the more violent part of it. This brig, like the *Robin Gray* in the Rodriguez hurricane, "kept right before it," and scudded round the storm.

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* See "Law of Storms," by Colonel Reid.

The *Blenheim*, 74, and *Java* frigate, foundered on this occasion, and afford a striking example of how little the size, or perhaps even management of a vessel, has to do in influencing her fate, when once within the overwhelming force of a vortical tempest.

THE "NEPTUNE'S" STORM OF 1834,*

(*No.* 15 *track on the chart.*)

Is almost similar in every particular to the *Rodriguez, Blenheim*, and *Culloden* hurricanes. The *Neptune*, in long. 68° 20′ E., lat. 22° 30′ S., first began to feel a N.W. swell, and the breeze getting fresh from N.N.E. to north, and the barometer 29.80. From these facts, we should calculate the vortex to have been about 250 miles to the N.W., perhaps about lat. 21°, long. 64° 20′ E.

The *Neptune* was steering W. ½ S., and supposing the storm moving S.W., she was approximating to it in the same way as the *Katherine Stewart Forbes*, in the first storm given in this volume. On the 1st February, in lat. 23° 36′, long. 66° 23′ E., the wind was E.N.E., and rapidly increasing.

On the 2nd February, she ran to the westward 138 miles, till compelled to heave-to about lat. 24° S., long. 63° 10′ E. Here, with the gale at E.N.E., she lay till the vortex passed over her, and carried away her topmasts, &c. On the 3rd, in the middle of the storm, "at 2 P.M. it suddenly abated, and soon fell calm, with a dark dismal appearance and constant rain," and at 8 P.M. it recommenced from the west, and "blew hard." Barometer 29.10.

The wind in the log is put down E.N.E. the whole time, and shows her position in reference to the centre to have been nearly the same as that of the *Rambler* in the Rodriguez gale. This ship, by being twenty-four hours near the vortex, when hove-to, shows how slow its motions were; and the calm lasting *six* hours, joined to other circumstances, confirms this important point. Although it is not stated in the log that any change took place in the wind, it is obvious, from the gradual falling off of the ship's head from north and N.W., to N.W. and west, that the wind veered from E.N.E. to N.N.E., and after the calm, her head "south off S.E.," indicates the wind to have been W.S.W. Had the *courses* not been given, we should have supposed the wind scarcely changed. This fact shows that reliance cannot always be placed on the state of the wind near the storm's centre, as reported in log-books, in cases where a single ship encounters a gale.

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* "Law of Storms," by Colonel Reid.

THE "BUCCLEUCH'S" STORM OF 1834.

(*No.* 16 *track on the chart.*)

The storm, although severely felt at Mauritius, does not appear to have been passing over the island, and the vortex was, in all probability, about 100 or 150 miles to the eastward. This is inferred from information which we have received from Mr. Biddle, who was in command of a ship called the *Asia* in the same gale. A note from that gentleman, of the winds, weather, and positions of the vessel on this occasion shows that she was nearer to the Mauritius by 90 or 100 miles than the *Buccleuch*, and had the centre of the gale passing her to the *eastward.*

Judging from the weather and winds of the *Buccleuch* and *Asia*, we conclude that the vortex of the gale must have been about lat. 20° S., long. 61° 30′ E., on the 19th January; and on the 20th, in lat. 22° long. 60° 30′ E.

On the 21st, the *Buccleuch* was in lat. 24° 35′ S., long. 61° 49′ E., steering westward towards the path of the storm, with the gale at E.N.E. On the same day the *Asia* was in lat. 24° 4′ S., long. 59° 30′ E., with the wind at E.S.E. and E. by S., nearly in front of the storm's centre. From this it would seem that the vortex was about lat. 23°, long. 60° E.

On the 22nd, the *Asia* kept running before the storm, and continued so for sixteen hours, with the wind at east veering to south and S.W. By this course she ran round the west side of the vortex, as in the case of the *Harrier*, &c. At 4h. 30m. A.M., the vessel was hove-to, but being now behind the centre, found that "the gale was broken." It appears to have "blown awfully," but, by getting out of the way of the focus, this vessel, in all probability, escaped the chance of such serious damage as that sustained by the *Buccleuch*. The barometer fell in forty-eight hours from 30.50 to 29.25. This note having reference to nautical time, ends at noon on the 22nd.

On the same day, also at noon, the *Buccleuch* was in lat. 25° 39′, long. 57° 32′ E.; and by having been twelve hours after the *Asia*, she appears to have approached the central path of the storm almost at the moment when the vortex was passing, or rather just in front of it. When "the gale was broken" with the latter vessel, the former had it in all its fury for the space of twelve hours longer.

On the 23rd, both vessels were behind the gale, and had westerly winds. As the whole log of the *Buccleuch* is given in the "Law of Storms," it is unnecessary to repeat it in this place.

We must not omit to mention the fact of the barometer on board the *Buccleuch* having only fallen to 29.76, while that of the *Asia*, although farther from the focus, was at 29.25, more than an inch below its level previous to the gale. The sympiesometer of the former ship, however, fell 82 below the barometer, and was as low as 28.94, but previously to the gale the two instruments only differed .32.

The progress of this storm would seem to have been equally slow as in other cases which have been already noticed. On the 19th it was felt at Port Louis, about lat. 20° S., and at noon, on the 22nd, it was about lat. 25° 40′, or nearly 110 miles of southing daily, and its course about S.W. or S.S.W. by compass.

THE "NORTHUMBERLAND'S" STORM OF 1839,

(*No.* 17 *track on the chart.*)

May briefly be disposed of, owing to the imperfect information with which the log of the *Northumberland* furnishes us on points of importance in discovering its true character. This vessel, on her passage from Calcutta to England, encountered a tremendous hurricane somewhere to the eastward of Rodriguez. As the latitude is not mentioned for several days before the gale, and the longitude never once entered from the time she left Calcutta, the only means we have of calculating the probable place where she first fell in with bad weather is by the fact of her being in lat. 20° 39′ S., long. 74° 43′ E. three days after she was dismasted.

As her log presents a vivid picture of what takes place on board of a vessel during a hurricane, we give it in full on the day she sustained so much damage :—

On the 5th March, her course was 180 miles S.W., with cloudy weather, and the wind S.E., veering to E.N.E.

On the 6th, she made 176 miles more to the S.W. and S.W. ½ W., with the wind at E.N.E., E. by S., and ending at S.E., increasing, squally, and accompanied by *heavy rain*. Under double-reefed topsails, ship rolling heavily, and taking in much water. Her lat. was, in all probability, about 18° S., and long. 76° E.

Extract from the Log of the NORTHUMBERLAND.

Hour.	K.	F.	Course.	Winds.	Bar.	Remarks.
P. M.						7th March. P.M. commences with strong breezes and a high sea. Weather very threatening. Sent the royal-masts and top-gallant yards down. Ship rolling heavily and taking in large quantities of water. Close-reefed the topsails and furled mainsail. A strong gale of wind with very heavy sea, ship rolling and straining greatly. Furled fore and main topsails. 4 P.M. do. weather. 4h. 30m. Ship under foresail and fore-topmast-staysail. Loosed the main-topsail under close-reef and sheeted it
1	7		S.W.½W.	S.E.		
2	7					
3	7					
4	7					
5	7					
6	6	4				
7	7					
8	7					
9	7				29.20	
10	9					
11	9					
12	9					
A. M.						
1						
2						
3						
4						
5						

Extracts from the Log of the NORTHUMBERLAND—*continued.*

Hour.	K.	F.	Courses.	Wind.	Bar.	Remarks.
						7th March, *continued.*
6						home, hauled the foresail up and hove-to. Gale increasing, took in topsails and housed topgallant masts and made all secure. The sky had a strange vivid effect. Barometer falling. Wind still increasing with a heavy sea. Ship lurching and rolling dreadfully.
7						
8						
9				S.W.	28.30	
10						
11						
12						

10h. 30m. The main-mast went, cut away the rigging to clear the wreck. The poop, skylight, and the starbroad quarter-gallery were carried away with the mizen-mast. Gale increased to a perfect hurricane. Long-boat and spars got adrift, and greatly damaged. Ship rolling gunwales under, and shipping great quantities of water, which passed down to the lower-deck through the holes for the main and mizen-masts.

The stores, cargo, baggage, cabins, &c., all gave way, and *were carried from side to side with the greatest violence.* At 1h. A.M. shipped a very heavy sea which completely destroyed the poop cabins, cuddy, &c., carrying everything away from under the poop-deck.

At 2h. A.M., the foremast went about sixteen feet above the deck, carrying away the jib-boom and everything belonging to the mast. The hurricane blowing with unabated fury. Larboard quarter-boat was blown on board and destroyed. Cut away the wreck of the foremast, and everything belonging to it. At 3h. 30m. much lightning. At 8h. A. M. more moderate. Ship lurching and straining greatly, and shipping large quantities of water as before. At noon the rudder went, tearing away the trunk, and everything belonging to it.

On the 8th, the vessel "was lying a mere wreck," labouring heavily, and the gale blowing strong, but gradually abating, so that by the end of twenty-four hours the weather was such as to enable them to commence rigging jury-masts.

On the 9th, light winds and a heavy sea.

THE "EXMOUTH'S" STORM OF 1840.*

(*No.* 18 *track on the chart.*)

The ship *Exmouth,* during her passage from Bombay to England, when south of the equator, encountered two successive storms within three days of each other, and there is every reason to believe that they were one and the same. The first had all the character of a rotatory gale; and the second occurred almost in the same situation as that where the *Northumberland* was dismasted in the previous year, and seems to have been equally violent and disastrous. Several vessels are supposed to have foundered on this occasion. But there are other peculiarities in the storm worthy of careful consideration, as will be seen in the following extracts from her log, which we are obliged to condense, to a certain extent.*

On the 26th April, the *Exmouth* was in lat. 9° 37′ S., long. 79° 32′ E., with the wind S. by E., blowing a strong breeze, and squally, so as to oblige her to take in the top-gallant sails.

By noon on the 27th, she had run 126 miles S.W. by S., and must have been about lat. 10° 40′ S., long. 77° 40′ E. The weather unsettled, and wind increasing to a heavy gale from *south,* attended by "hard squalls, and lightning in the S.S.W." In the course of the afternoon, she was under such low canvass that her course was only 1¼ mile W. by N.

Extracts from the Log of the ship EXMOUTH.

Hours	K.	F.	Courses.	Wind.	Remarks.
A. M.			Hove-to.		Tuesday, April 28th, 1840.
1			S.E.byE.		A. M. Blowing a fresh gale with a heavy sea, hauled the fore-topsail up and stowed it. At 4h. sea very heavy and ship's head to westward. 8h. Appearance very threatening, close-reefed main-topsails, sent down top-gallant yards, housed the topmasts, and made the ship snug for a hard gale.
4			OffE byS	S.S.W.	
			W.S.W.	South.	
			off		
P. M.			West.		
2					
			S.W. off	W.N.W.	
6			S.S.W.		

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* For additional information connected with this hurricane, see Appendix.

Extracts from the Log of the EXMOUTH, (*continued.*)

Hours	K.	F.	Courses.	Winds.	Remarks.
			Up SW.byW offS.S.W	NWbyW	At noon, bar. 29.76, inclining to sink. Sun obscured. P. M. Blowing very hard with a high sea. Wind veered round to the W.N.W. In main-trysail. Midnight. Blowing a heavy gale. Sea very high and cross, ship labouring and plunging heavily, and shipping much water.
A.M.					Wednesday, April 29th, 1840.
1			Up S.W. offSbyW	W.N.W.	A. M. Lightning and rain. Blowing a heavy gale, ship lurching and pitching heavily, shipping much water over all.
P. M. 1			Up SW.byW offSbyW		Noon. Do. weather, with a wild appearance. Bar. 29.60. Sun obscured. P. M. People employed setting up preventer lashings to booms and launch, and securing quarter-boat.
A. M.					Thursday, April 30th, 1840.
			Up S. by W. off S.S.E.	West.	A. M. Gale inclined to moderate. A heavy sea running. The day broke with a most singular phenomenon, the whole heavens and horizon appeared perfectly red, every part of the ship partook of the same appearance, and the men on deck for the moment were changed from white to red. This appearance lasted for five minutes.
P. M. 1	3		S.S.W.	N.N.W.	
4	3	4			
8	4			N.W.	
10	4				
12	4				P. M. The gale moderated with a fresh breeze and sea falling. Made sail. Midnight. The sea still continued heavy and confused; ship very uneasy.

On the 1st May, this vessel running south, was in lat. 11° 36′ S., long. 77° 10′ E., barometer 29.90. She had the wind blowing a "fresh breeze" from north to N.N.E., and in the course of the day, when nearly about lat. 12° S., she "*passed a ship's lower mast and rigging, supposed to have been cut or carried away in the late gale.*"

On the 2nd May, her course was S. by W. and S.S.W., with the wind at N.N.E. to N.E. Strong breezes and cloudy. Top-gallant sails taken in. At noon, in lat. 14° 51′, long. 76° 40′. From this time till the 3rd (civil time), she ran 108 miles to the S.S.W. We now give her log in full for the next three days.

Extracts from the Log of the EXMOUTH, (*continued.*)

Hours	K.	F.	Courses.	Wind.	Bar.	Remarks.
A. M.						Sunday, May 3rd, 1840. A. M. Strong breezes and cloudy. Daylight. Increasing breezes and thick hazy weather. Noon. *Observed several clouds of a singular appearance pass from the N.W. to S.E. Saw two waterspouts in the E.N.E.* P. M. Wind freshening. In lower and topmast-studding-sails; took in first reef of topsails. At 8h. pumped ship at 14 inches; carpenter reported lead pump out of order. Fresh breezes and cloudy. Although there was nothing particular in the appearance of the weather, Captain Warren ordered the royal and mizen topgallant-yards to be sent down, and flying-jib-boom to be housed. At 10h., the weather assumed a very different appearance; unsettled, with increasing breezes, rain, lightning, and distant roll of thunder. Turned the hands out, in third reef of topsails, stowed jib, mainsail, and driver, and furled fore and main topgallant-sails. Pumped ship at 18 inches.
1	9		SW by W	N.E.		
2	9					
3	9					
4	9					
5	9					
6	9					
7	9					
8	9					
9	9					
10	9					
11	9					
12	9		S.W.		30.20	
P. M.						
1	9					
2	9					
3	9					
4	8					
5	8					
6	8					
7	7					
8	6				29.90	
9	6					
10	7					
11	8					
12	8				29.70	
A. M.						Monday, May 4th, 1840. A. M. Wind increasing to a hard gale, with a rising heavy weather and lee sea. Hauled down the fore-topmast-staysail, which was blown to pieces, and hove the ship to under
1			Up S. E. by S. Off SSW.	E.N.E.		
2						
3					29.80	
4						
5					29.70	
6						

Extracts from the Log of the EXMOUTH (*continued.*)

Hours	K.	F.	Courses.	Winds.	Bar.	Remarks.
7					29 00	Monday, May 4th, *continued.* close-reefed main-topsail. Ship lurching very heavily, and shipping much water over all. Carpenter sounded the pump well, and reported 20 inches. Sent the watch below to draw her out, but to our surprise we found the starboard pump would not work. At 2h. furled the main-topsail. The gale suddenly increased to a violent storm. All hands employed securing boats, spars, &c., with extra lashing. The carpenter securing and battering the hatches down with extra tarpaulin, and making everything as snug as the sudden change would allow us. At 3h. The head of the iron spindle of the rudder, from the
8						
9					28.90	
10					28.60	
11					28.60	
12						
P. M.						
1			Head to westward.	E.N.E		
2				S.S.E.		
3						
4						
5						
6						
7						
8					29.90	
9						
10						
11						
12					29.90	

violent working, twisted off. Knocked down the fore and aft bulkheads in lower great cabin, and shipped the lower spare tiller, and secured the pendants. The storm now increased to a furious hurricane. Ship labouring very hard, and shipping much water fore and aft. The carpenter reported three feet in the hold, and much water on lower deck. Pumps quite useless. All hands employed baling with buckets, from pump well and lower deck.

At 4h. The lower tiller broke in the rudder and carried away the pendants. Fitted and shipped it the third time. It again broke in a few minutes, and the rudder was twisted from the stern-post. Shipped much water through the rudder trunk, secured it as well as we could. The water now increased on us to four feet in the hold.

At 6h. Wind blowing in violent gusts, and blew away the jib-boom, spritsail-yard, and fore and mizen topgallant-masts. Cut away the main-topgallant-mast.

At 11h. Do. weather, wind and sea sweeping everything on deck before it, carrying away the lee-quarter-boat and waist-hammock netting.

At 11h. 30m., we had a *most tremendous squall, which continued only for a few minutes, and then lulled away into a perfect calm.*

Remarks (*continued.*)

Noon. *Calm.*

P.M. Calm still continued and a most awful silence prevailed: ship tumbling about in the trough of the sea quite ungovernable, and the sea making a fair breach over us. At this moment *the quicksilver disappeared in the tube* of the barometer, which Captain Warren supposed was caused by some injury it had received, or that we should have a return of the hurricane with greater violence.

At 12h. 20m. the *sun made its appearance for a few minutes,* and then disappeared, followed by an awfully hollow and distant rumbling noise. In a few minutes we received a *most terrific gust from the S.S.E., laying the ship completely on her beam ends, blowing away the fore-topsail-yard: weather quarter-boat torn from her lashings, and flying over lee quarter in several pieces.* All the cabins and quarter-gallery on the starboard side of poop washed away, and the ship in a sinking state. Captain Warren consulted with his officers, and considered it as the only alternative to save the ship from foundering to cut away the fore and mainmast, which was done, carrying away the mizzen topmast and ripping up the forecastle deck, when the ship righted and was much easier, but rolling violently. We were now left like a half-tide rock, sea making a constant breach over us. No pumps working. Mast and rudder gone. Eight feet water in the hold, two on lower deck, the ship settling fast in the water, and the hurricane still blowing. In this awful situation we remained until 5 P.M., when, to our great joy, we got the starboard pump to work, and soon gained on the water in the hold.

At sunset the violence of the wind began to decrease, and the gusts were less frequent. At 8 P.M., the quicksilver rose in the tube of the barometer to 29·00 as suddenly as it fell, and which no one on board could account for, having narrowly watched it.

Midnight. Succeeded in reducing the water in the hold to five feet. Wind decreasing, ship lying a perfect log in the water, and the sea making a clean sweep over us fore and aft.

Hours	K.	F.	Courses.	Winds.	Bar.	Remarks.
A. M.						Tuesday, 5th May, 1840.
1			Head to the westward.	S.E.		A. M. Wind suddenly moderated into a *fresh gale.* All the ladies collected in the lower great cabin, the only safe place left in the ship for them.
2						
3						
4						
5						

Extract from the Log of the Exmouth (*continued.*)

Hours	K.	F.	Course.	Winds.	Bar.	Remarks.
						Tuesday, May 5th, (*continued*).
6			Ship drifting to the W.N.W.			At daylight found the ship much by the head, in consequence of the sugar being washed out in the after hold. The starboard pump again got choked, and the water increasing in the hold.
7						
8						
9						
10						
11						
12						
P.M.					29.90	Noon. Water in the hold increased to 6½ feet, commenced throwing the cargo from fore and main hatchways overboard.
1						
2						
3						
4						P.M. Got the starboard pump to work again, wind moderating.
5						
6					30.10	At 4h. Wind moderated into a steady breeze and the weather cleared up. Sea fast falling, found the ship rising forward and much more easy. Pump again stopped working. Bent new mizen, and set it.
7						
8						
9						
10						
11						
12						
						Midnight. Moderate weather. People employed baling with buckets from the pump-well and lower-deck.

"On the 6th May, the ship was rolling and tumbling about in the trough of the sea, and making much water, but the weather moderate. Ship drifting W.N.W., without masts or rudder."

On the 7th, fine clear weather; bent the stream cable to the "kedge anchor, and paid it out to the end; found it kept her head to the sea." Ship driving to W. by S., wind S.E.

On the 8th, drifting W.S.W.; no wind mentioned in the log. The weather fine, lat. ob. 18° 35′ S.

On the 9th, got the jury-rudder shipped; found it to act very indifferently. Weather rather unsettled, wind S.E., and light; lat. ob. 19° 4′ S.

This is another case where a ship meets with a storm on leaving the westerly monsoon in lat. 10° 30′, long. 77° E. By lying-to for three days, the barometer falls to 29.60, and rises in the same gradual manner; while the gale and weather increase and subside in a relative degree, and the wind veers half a circle from south by west to north. By applying the positions of the *Exmouth* to the circles around the moving foci of the Rodriguez storm, on the chart, an explanation of the course and character of this storm is at once obtained. It would lead to the supposition that the centre of the first gale passed her about 100 or 120 miles to the southward, in the usual track between 12° and 13° S. This is made more evident by the fact of a "lower mast with its rigging" having been discovered about two days after the gale, in its probable wake, and is also indicative of a greater degree of violence at this point than where the *Exmouth* was.

When behind the first gale, with the wind at north, the *Exmouth* commenced running about 200 miles in the twenty-four hours; south one day; S.S.W. the next; and S.W. the third; with the wind gradually veering to N.N.E., N.E., and E.N.E., and increasing in force till it ended in a hurricane. The barometer descends from 30.20 to below 28.60 in twenty-four hours, and nearly in the same space of time is again up to 30.10. The focus passes near her, and the wind suddenly changes from E.N.E. to S.S.E., or, as Captain Warren mentions in a note, "it might have been a point more to the southward." From the fearful situation in which the vessel was, before and some time after the vortex passed her, we cannot expect that men's minds would be directed to minute points, of so little immediate consequence in keeping their almost foundering vessel above the water. Still there is enough to show that the storm, even on this occasion, did veer more than a quarter of a circle in a few hours, and that two opposite winds were blowing, by the "*weather and lee sea*" experienced at its commencement; while about twelve hours before the violence of the storm was at its height, clouds were seen driving from N.W. to S.E., and two waterspouts were observed. Generally speaking, however, the abstract information regarding the state of the winds, derived from one vessel, is very inconclusive in deciding on its rotatory and progressive motion. In the Rodriguez storm, the log of the *Rambler*, by itself, would not show anything of an obviously rotatory action, and the same may be said of that of the *Blanche*, yet both, in connexion with *other* observations, are important in determining this.

However, the vortical nature of this hurricane seems to be clearly made out; it is also manifest that it was progressive, and was met with at two different points, along the ordinary route followed by revolving gales. The impression which it leaves on our mind is, that it was moving in diurnal stages more slowly than usual, considerably less than 200 miles per diem, or the *Exmouth* could not have gone round its S.E. side as she did. But as it took place much later in the season than any other with which we are acquainted, its slower rate of progression may be accounted for by the changing state of the atmosphere in May. In this, however, as in the whole subject of storms, there is a wide, and almost untrodden field for those who have time, opportunity, and patience to explore it. Perhaps this gale may hereafter be more fully traced.

It is very probable that the same storm passed Mauritius, for on the 13th, 14th, and 15th, we had strong S.S.E. gales, with "cumulo-strata clouds," heavy rain, and a "high sea rolling on the coast." On the 16th, the wind had gradually gone round to N.W. On the 15th I find a note that "two contrary currents, the higher from E.N.E. and the lower from S.W." were blowing.

THE "FAIRLIE'S" STORM OF 1844.

(*No.* 19 *track on the chart.*)

This ship, on her voyage from China to England, with the head-quarters of the 55th regiment on board, encountered a tremendous hurricane soon after she left the Straits of Sunda, and when a few hundred miles to the S.S.W. of Java Head. Although the log, in detail, has not been procured, we are enabled, through the kindness of the officer in command of the *Fairlie* on that occasion, to give a description of it in his own words, as follows:—

On the 10th April, 1844, the wind was *north west*, with a high *cross sea*, causing the ship to roll very much, but no appearance of a gale. Barometer and sympiesometer stationary.

April 11.—At noon it commenced to blow a strong breeze from *north*. Sympiesometer falling, barometer stationary. At 4 P.M., increasing to a gale, with the wind still at north, accompanied by rain, and the *sea rising high and confused;* the barometer and sympiesometer fallen very much. Every preparation was made to encounter a hurricane. At 5 P.M., the wind still very steady at north, but very threatening to the westward. At this time the barometer had fallen 1¼ inch, and there was every appearance of a severe hurricane. Sent the small yards down, bent a new main topsail, and close-reefed it, furled all the other sails except the foresail, secured the hatchways, lower deck ports, &c. At 6 P.M., the wind at N.N.W., blowing a strong gale, with severe sudden gusts, and rain; and the sea rising very high. At 9h. 30m. P.M., a sudden and terrific gust caught the ship, and blew away the foresail, and in five minutes afterwards the close-reefed main-topsail was blown clean away. The wind veering to N.W., blowing a most furious hurricane. The wind suddenly veered to W.S.W., laid the ship to, under bare poles, with her head to N.W. At 10h. 15m. P.M., the gale increasing to a most furious height, and rendered it impossible for a person to stand on the decks. The wind, now at S.S.W., with awful lightning flying about in all directions; large balls of fire, or meteors, were seen at every yard-arm, mast-head, or boom-ends. Appearance most awful! At 11 P.M., no words can describe it; the larboard quarter-boat was blown on board, carried furiously across the deck, and disappeared to leeward. I could perceive, from the flashes of lightning, that all the masts and yards were blown away, with the exception of the bare lower masts, and the ship was nearly on her beam ends, while the sea was making a complete breach over her. I was lying down at the time on the poop-deck, with the second officer and four seamen, and found it impossible to move from our positions. About midnight, the hurricane howling terrifically, the sea and lightning beyond description. I now gave up all hopes of the ship remaining much longer above water. From the flashes of lightning (no thunder), *a heavy cloud seemed to be down upon us.* As everything on deck was washed away, including the binnacle and compasses, I could not ascertain the true point of the hurricane, but I supposed it to be S.W. At 2 A.M., the storm still unabated; very little hopes of keeping above water much longer. At 3 A.M., not quite so violent. At 4 A.M., hurricane subsiding; heavy rain. I now got down from the poop-deck, and found the ship presenting the appearance of a mere wreck, nothing standing but the lower masts. At 4h. 30m., wind at *south*, and gradually veering round to S.E., and continued to blow a fresh gale. The wind was afterwards S.E. the whole time I was in the limits of the trade wind.

This hurricane occurred in lat. 12° 2′ S., long. 103° 41′ E., and had not the *Fairlie* been a strong teak-built ship, with a kind Providence, she must have foundered with all on board.

Off the Cape of Good Hope, I boarded a Dutch ship, and compared my log with his on the day of the *Fairlie's* hurricane. He was in the same latitude as the *Fairlie*, but 180 miles farther to the *eastward*, and did not experience anything of the hurricane, but had a *heavy rolling sea, and a dense atmosphere.* He told me he suspected a hurricane was not far off.

JOHN ROSKELL,
Commander of the *Fairlie.*

The foregoing account of the *Fairlie's* hurricane was received at the time when these papers were about to be sent to the press, and adds very strong corroboration to what has already been advanced on the subject of other storms. It appears to have occurred almost in the same situation as that of the *Artemise*, and exactly at the junction of the N.W. monsoon and S.E. trade-wind. The *Fairlie* had N.W. winds, increasing in violence for a day or two before she got into the centre of the gale, and afterwards got the S.E. trade.

The veering of the wind would indicate the same uncertain motion of the vortex as in the *Artemise*, and other storms experienced in the neighbourhood of Sumatra and Java, and in all probability dependent on the incipient operation of the primary causes. A subsequent note from

Mr. Roskell states that the vessel was running right before the storm, at twelve miles an hour, till she was hove-to. But, as in other cases where only one ship is present, it is difficult to come to any decisive conclusion with regard to its progressive movements,—more especially where the vortex passes during the night, and it is impossible to note the direction of the wind.

It is clear, however, that the *Fairlie* ran into the storm, and when she ceased to scud, it passed by, indicating that it was progressive, and her having experienced the usual cross sea, as she approached it on the previous day, proves that it was not suddenly formed.

The information derived from the Dutch ship, which was 180 miles to the eastward, and felt the swell and suspected a hurricane, equally shows that it did not move in that direction.

By mere accident we possess a few notes, which otherwise would have been valueless ; but in connexion with the above account, would lead to the supposition that this hurricane followed the usual track to the S.W.

On the 10th April, 1844, the *Madagascar* was in lat. 10° 10′ S., long. 84° 55′ E., about 20 degrees to the westward of the *Fairlie*, and had a strong squally S. by E. wind, with one reef in her topsails, and the barometer at 29·80.

On the 11th, she was in lat. 12° 15′, long. 82°, wind S.E., "strong trades." On the 12th, the same vessel was in lat. 13° 56′., long. 79°, strong breeze, and a *squall carried away the fore topmast.* Barometer 29.80.

On the 14th, she was in lat. 17°, long. 75°, 39′ E. Strong S.E. trade.

On the 22nd April, 1844, the *Windsor* was in lat. 20° S., long. 73°, and had strong winds at S.S.E. with "*squalls*," cloudy weather, and a "heavy *confused sea.*"

These notes, at least, show a stormy condition along the track which the *Fairlie* hurricane may, in accordance with others, be supposed to have followed. The cross, confused sea, is perhaps the most conclusive sign of a rotative gale being near or having passed.

RODRIGUEZ STORM OF 1844.

This island was visited by a severe hurricane, which threw down the greater number of the habitations, and so completely destroyed the cultivated parts of the country, that some apprehensions were entertained lest the poorer classes should suffer from famine. The more violent part would appear to have commenced at 2 P.M. of the 20th February, and lasted till 4 A.M. of the 21st; and according to the official report made to His Excellency the Governor of Mauritius, it "caused immense damage."

The state of the barometer, or veering of the wind, cannot be ascertained at present, but Sir John Marshall, who went to inquire into the condition of the inhabitants, informs us that the storm swept round the island. The swell caused by this gale was felt by H.M.S. the *Isis*, about 450 miles to the N.W. of the island. This frigate, on the 21st February, was in lat. 12° 48′ S., long. 56° 29′ E., chr., with a N.W. wind, when she encountered such an enormous sea rolling from the S.E., which lasted for two days, as at once led to the suspicion that a hurricane was not far off.

As all hurricanes at Rodriguez begin at E.S.E. or S.E., this in all probability did so also, and the swell experienced by the *Isis* corroborates the supposition. Thus, as in other cases, showing the trade wind prevailing at one side of the storm's path, and the N.W. monsoon at the other.

MAURITIUS HURRICANES.

Although the subject is, as regards certain points, familiar to every one who has resided long in this beautiful island, the accounts which we received were chiefly concerning the effects of hurricanes on the island, the loss of property and personal suffering, or the almost incredible force of the wind. Interesting as these details are, still, as they do not directly belong to the objects which we have in view, it is unnecessary to refer to them further than has been already done.

The general features of these tempests are; that for some days they are usually preceded by strong gales and heavy rain from the direction of the trades; begin at S.E., and end at N.W., sending into Port Louis harbour that tremendous surf which sometimes throws every vessel on shore. When the centre passes, it is always marked by a calm of several hours about the middle, or between the S.E. and N.W., parts of the storm. It may be calculated that the passage of a storm over the island, from the time that the barometer begins to fall till it has regained its usual level, is seldom under seventy-two hours, and if with a progressive motion of five miles an hour, would give the diameter of the circle 360 miles. By a proper system of observation at different points of Mauritius, the extent of the focus or calm, and the state and direction of its advance, might be determined with considerable precision, and other equally valuable observation might be made at the same time. Something, however, may be attempted even from the scanty and detached facts already known.

THE GALES OF 1811.*

(*Nos.* 20 *and* 21 *tracks on the chart.*)

These two storms mentioned by Colonel Reid are, to a certain extent, made out to have been moving about the rate which seems to accord with others in the same latitude.

On the 5th March, the *Racehorse*, in lat. 19° 39′, long. 58° 28′, had the storm blowing at S. by E.; but she appears to have been about 24 miles further east, when, at 5 P.M., the vortex passed over her. In about lat. 19° 30′, long. 59° E., next day, the wind was N.W.

On the 6th, the focus would seem to have been at Port Louis about 100 or 120 miles from where it was on the previous day.

The second gale, which took place only sixteen days after the last, and pursued a track very little farther to the eastward, is somewhat more clearly developed. On the 19th March, the *Astrea*, in lat. 19° S., long. 58° 33′ E., had a heavy gale blowing at south. About midnight, or early next morning (20th), when her position must have been about 19° S., long. 58° 20′ E., the veering of the wind indicates that the vortex was beside her. This corresponds to the probable time when it passed the *Nisus*, very near to the *Astrea*.

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* "Law of Storms," by Colonel Reid, C.B.

Now it seems to be evident, from the logs of the three ships lying in Port Louis harbour, that the centre was only past about the morning of the 21st, or twenty-four hours after it left the *Astrea* and *Nisus*. The distance which it travelled during this period could scarcely exceed 100 miles.

THE MAURITIUS HURRICANE OF 1818.*

(*No.* 24 *track on the chart.*)

Which took place on the 28th February and 1st March, began at S.S.E., and veered round by east to N.N.E., north, and N.W.—leading to the conclusion that the centre passed westward of the island, to the S.W., and, in all probability, considerably to the eastward of Bourbon, as it was much less severely felt there than at Mauritius. Every ship in Port Louis harbour was thrown on shore except the *Jason*. The passage of a storm's centre, to the westward of the island, or directly over it, is always attended by severe damage to shipping in Port Louis harbour, which is open to the N.W.

THE HURRICANE OF JANUARY 1819.

(*No.* 22 *track on the chart.*)

Which visited Mauritius, has the appearance of the focus having passed over the east side of the island. The wind began at S.E., and went round by south to west, N.W., and north. Very little else is known about it.

THE SECOND STORM OF 1819.†

(*No.* 23 *track on the chart.*)

Took place on the 29th March, but had been preceded for two days by unsettled weather, squally, with rain, and the barometer falling. It commenced in the usual way from east to south • At 4 P.M. of the 29th, it began to subside, and at 4h. 30m. was "quite moderate," and "wind veering round to N.E." and N.W. By 8 P.M. it was again a storm from W.N.W. and N.W. to north. The barometer fell to 28.98.

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* "Law of Storms," by Colonel Reid, C.B. † Id.

This is another instance of that lull in the centre of a hurricane which a distinguished philosopher has denied to be possible.

THE HURRICANES OF 1824.*

(*No.* 24 *track on the chart.*)

In this storm of the 23rd February, as there is no mention of lull or calm in the middle, and the wind veered from S.E. to E.N.E., N.N.E., north, and N.W. to west, it may be inferred that the focus was passing west of Port Louis. It also explains the loss among the shipping in the harbour, thirty sail having been driven on shore from their anchors.

The *Asia* was off the north end of Mauritius on this occasion, and by the sketch of her course on a chart, and verbal information obtained from her commander, we are inclined to think that she must have had the vortex passing between her and the north end of the island, as she had the wind from E.S.E. to south and SW. on the 23rd. On the 24th, in lat. 20° 20′ S., long. 59° E., the wind was S.W., veering to N.W.

From Port Louis in Mauritius, to St. Dennis in the island of Bourbon, the distance is about 120 miles, S.W. by W. On the 23rd, when the hurricane was blowing with all its fury at the former place, the weather was by no means bad at the latter, and it appears that the centre of the storm did not pass Bourbon till the evening of the 25th. At least, on this night the north and N.W. wind blew "*mais sans une extrême violence,*" and sent a swell on the coast that drove several vessels ashore.

The time, then, which the vortex must have taken to travel the distance between the two above-named places, could not have exceeded thirty-six hours, more likely about thirty. Therefore, it being analogous in this respect to other storms, we infer that its progression was about four or five miles an hour, and its direction S.W., as it evidently passed to the eastward of Bourbon.

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* "Law of Storms," by Colonel Reid, C.B.

The barometer fell at Port Louis to 28.45, when the wind was at N.N.E. At Bourbon it was down to 27.7 (French) on the night of the 25th.*

THE HURRICANE OF 1836.

(*Same as No.* 23 *track on the chart.*)

Seems to have been carefully observed by Colonel Lloyd, the Surveyor of Works at Mauritius, in charge of the Observatory at the time, and the result of his labours was published in the *Nautical Magazine* for June 1837, and also quoted in the "Law of Storms."

The state of the weather, barometer, and fall of rain, have been minutely recorded, and agree so well with every thing that we have read and seen of hurricanes, that we would strongly recommend it as a valuable article to be studied by those who take an interest on the subject. The *general* veering of the wind is also in conformity with other circular gales, but the sudden variations from one point to another, while it was raging, can only be received with certain modifications, owing to the Observatory at Port Louis being situated on the level of the sea, and, like the rest of the town, overlooked by a lofty range of mountains, about 2,000 to 3,000 feet high, extending from east to S.W., which divert the wind into new channels, directly at variance with that of the open ocean. Near the vortex this sudden gyratory motion of the atmosphere is always observed.

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* In connexion with this storm, it is worthy of notice, that on 22d February, 1836, the ship *Woodford*, from Madras to London, encountered a hurricane in lat. 12° S., long. 84° 22′ E., which lasted for three days. She lost her masts, and was left a mere wreck. A painting of this vessel on that occasion is in possession of Sir Charles Forbes, of Craigievar.

From what has already been brought forward to prove that storms come from the neighbourhood of the Indian archipelago, there can be very little doubt that that encountered by the *Woodford* was the same which arrived at Mauritius *twelve* days afterwards. The time and distance are quite in accordance with everything that is known on this head about the storms of the tract of ocean in question.

It is ascertained from Colonel Lloyd's observations, that the wind began to blow "very hard" about forty-two hours before the focus arrived at Port Louis. It can also be gathered from the apparent discordancy of the winds, that the storm commenced at S.E. and E.S.E., and ended at north, N.W. and N.N.W. The gale seems to have declared its true nature on the morning of the 5th of March, and gradually increased in "tremendous gusts," accompanied by heavy increasing rain, till about 4 P.M. of the 6th, when it began to abate, and by 5½ P.M. was quite calm. At 7½ P.M., it recommenced from the opposite quarter with equal violence and heavy rain. The lowest range of the barometer was 28.230, which occurred just before the calm began, and by the time it was over the mercury was up to 28.325. For about sixty hours it was raining "heavily," and 8.6 inches of water fell.

MAURITIUS HURRICANE OF 1840.*

(*No.* 25 *track on the chart.*)

For several days previous to this storm, the state of the barometer, and the unsettled character of the weather, led the inhabitants of Mauritius to suspect its true character. The following remarks were made at Souillac. On the 5th, 6th, and 7th April, a strong, and gradually increasing S.E. gale prevailed, of a blustry nature, attended by heavy rain, and a wild threatening sky, especially toward evening, when the struggling rays of the setting sun were strongly refracted, and threw that lurid dismal hue over the surface of the heaving waves and rocky coast, which is almost peculiar to the tropic, and generally forebodes the approach of a tempest.

On the 8th, the barometer at noon was 29.90, the wind

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* In the Appendix additional information will be found regarding this storm.

S.E. to S.S.E., blowing in severe gusts, with a continued fall of rain. The sea was rapidly rising, and breaking along the coast with great violence. At 9 P.M. the barometer 29.80.

On the 9th, the tempest began to unfold its terrific powers. The earth seemed to be enveloped in one dark covering of misty cloud, sweeping along its surface with great force, and pouring out rain in such quantity as to inundate the country; while the sea was rolling towards the coast in mountainous masses, and bursting over the coral reefs with a noise heard even above the howlings of the gale. The wind blew from S.E. to E.S.E. The barometer at 9 A.M. 29.70, at 10 P.M. 29.45, and by midnight it was down to 29.34. In the course of the night it was a complete tempest. On the morning of the 10th it still blew with overwhelming force; trees of gigantic stature were torn up by the roots, and strewn about on the ground like mere straws; buildings were thrown down, and all the wooden palings swept away. The effect of the wind was very remarkable on a group of tall filao trees (casuarina), from 60 to 80, or 100 feet high, very tough, and not easily broken; but before the irresistible force of the hurricane they bent down to an almost horizontal direction, and their graceful branches were drifting along with the blast like delicate plumes. It seemed as if the whole had suddenly been cut down, and, indeed, a great proportion of them snapped before the storm was over. As the vortex approached, and the wind began to be marked by lulls at one moment, and fierce spiral gusts at the next, we observed several of these trees, as if suddenly twisted round, broken off in an instant, and borne away for some distance on the breast of the tempest.

Nor was the state of the sea less extraordinary. As already remarked, the coast of Mauritius, near Souillac, is bounded by precipitous cliffs, on which the towering masses of sea were hurled with a violence which threatened to wash away its natural boundaries. The summits of the waves were carried by the wind high over the land, and the spray was borne into the interior for many miles, and, falling on the trees, left a saline taste on their branches and trunks for several days after the gale.

The rain meanwhile fell in torrents, driving horizontally along with the misty bed of vapour resting on the earth, and obscuring everything beyond the distance of a few yards; in fact, the atmosphere and its contents were swept along as if escaping from a highly condensed steam reservoir.

About 9 A.M., the severity of the storm began to subside to irregular blasts and calms. By 10 A.M., it was a light wind; in half an hour after, quite calm. It seemed as if the storm was over; the sky became lighter, the sun broke out about noon, and it was so fine that we walked through the village to survey the scene of devastation. Still the barometer continued low, and cumulous masses of clouds were occasionally seen drifting rapidly across the sky, from N.N.W. to S.E., or in the direction opposite to that whence the gale had ceased blowing.

At 2 P.M., a dark, lowering, well-defined, unbroken bank of clouds, was seen approaching from the N.E., following the lighter masses which had preceded it. It was like a canopy drawing over the mountain in the interior, and we could see that rain was poured out from it. Its motion towards us was by no means very rapid, and in no comparison with that of the clouds flying over our head. In half an hour after, a few angry squalls warned us of its proximity; and it again burst over the place, preceded by a confused roar, with a fury that baffles description. A complete shower of leaves, branches, and every light article that could be laid hold of, was brought along with this part of the storm. It now blew off the land at Souillac, and being in opposition to the sea raised by the opposite S.E. wind in the morning, a conflict, which we have heard described, but never saw before, took place, in which the crests of the waves were tossed in the air, and hid the outlines of the ocean and sky.

The hurricane from the N.W. continued with steady force till near midnight, when a marked abatement took place, and by the morning of the 11th it was merely a strong breeze, but accompanied by sulky blasts from time to time. There was, however, blue sky seen through the still fast driving clouds, and the sun broke forth about noon. On the 12th, it was fine, and the wind N,W.

The face of the country had indeed the appearance as if a "devouring blast" had passed over it. The rich, green, and luxuriant vegetation of the tropics, had as completely disappeared as if an arctic winter had suddenly laid its searing influence on the island. But we have little space to devote to this subject, or to the details of injury to the structures of human art, whether afloat or on shore.

As the movement of the storm's centre over the island may be calculated by the following Table A, it is introduced as likely to throw some light on the area which it embraced.

This table furnishes the means of deducing the extent and rate of progression of the "calm," or the centre of the vortex. It appears that at Port Louis, about 4 P.M., on the 10th, the S.E. part of the gale had begun to moderate, and by 5 A.M. there was a dead calm, which lasted till 9 A.M., when the gale recommenced from N.N.E. to N.N.W., and by 10 A.M., the wind was blowing a perfect tempest. At Souillac, twenty-one miles to the southward, the S.E. storm was at its height, and lasted till 10 A.M. The calm only set in at Souillac, about four or five hours after its appearance at Port Louis, and continued from 10 A.M. till 2 P.M., as we have described, at the very time when the N.W. part of the storm was raging at the latter place in its full strength, and throwing the vessels, in the harbour, on shore. Hence it may be inferred that the diameter of the calm extended from one place to the other; and as

TABLE A.

A Table of Simultaneous Observations on the state of the Barometer and Weather, at Port Louis and (21 miles further south) at Souillac, during the Hurricane of 1840.

AT PORT LOUIS.						AT SOUILLAC.			
Date.	Hour.	Bar.	Ther.	Wind.	Weather.	Bar.	Ther.	Wind.	Weather.
April 8	9 P.M.	29.92	78½°	S.E.	Blustry and raining.	29.80	78°	E.S.E.	Strong gale ; rainy.
„ 9	A.M.	29.82	78°	„	Ditto.	29.72	80°	S.S.E.	Ditto.
„ „	Noon	29.80	78°	„	Blowing strong.	29.66	78°	„	Blowing strong ; heavy rain.
„ „	10 P.M.	29.60	77½°	„	Stormy.	29.55	77°	S.E.	Gale increasing ; heavy rain.
„ „	Midnight	29.40	77°	„	A complete hurricane.	29.45	77°	„	
„ 10	1 A.M.	29.30	78°	S.S.E.	Ditto.	29.38	78°	E.S.E.	Tempestuous; raining.
„ „	2¼ „	29.20	78°		Ditto.	29.30	77°	„	Ditto and heavy rain.
„ „	3½ „	29.10	78°		Moderating.	29.20	77°	„	A violent tempest and rain.
„ „	7 „	29.10	78°		Calm.	29.10	77°	East	Ditto, ditto.
„ „	8 „	29.10	78°		Ditto.	29	77°	„	Ditto, ditto.
„ „	9½ „	29	78°	N.N.E.	A hurricane again.	28.90	77°	„	Wind dying away.
„ „	Noon	29.8	78°	N.N.W.	Ditto.	28.95	78°		Calm.
„ „	2 P.M.	29.15	78° 3′	N.W.	Ditto.	29.5	78°	N.N.W.	Wind commencing in squalls.
„ „	5 „	29.48	78° 8′	„	Less severe.	29.20	80°	„	Terrific hurricane.
„ „	9 „	29.88	79° 5′	„	Moderating.	29.35	78°	N.W.	Ditto, ditto ; raining.
„ „	10 „					29.45	78°	„	Still very violent ; ditto.
„ „	12 „					29.60	79°	„	Moderating ; rain.
„ 11	3 A.M.					29.70	78°	„	Blowing strong.
„ „	9 „					29.80	79°	N.N.W.	Squally.
„ „	Noon					29.90	81°	N.W.	Fresh breeze.
„ 12	„					29.95	86°	„	Fine.

From the 9th to 11th, the rain-guage at the Observatory of Port Louis indicated a fall of rain to the amount of 10.0.6 inches.

its northern margin, or after part, had left Port Louis, its anterior edge commenced passing over Souillac; and being four hours in passing over the distance in question, it may fairly be computed that its motion was not more than four or five miles an hour.

Of course it is not possible to define the total cessation of the gale to a few minutes, nor is it likely that the exact centre of the calm passed over either place, for in conformity with its ordinary course, it most likely passed between them, and thus, little nicety in the results can be arrived at. Still, the fact of four hours' calm at one place, ending almost to a moment as it commenced at another, twenty-one miles distant, must be received, in connexion with similar phenomena in other storms, as a distinctive feature of rotatory gales. In the present case it also conveys something like an approach to accuracy in the rate of daily progression of a storm in lat. 20° S., and of its direction to the southward. Its slow progress, after passing the island, is confirmed by notes from the log of a vessel to the S.W. of it at the time.

The *Sir E. Paget*, on the 9th April, 1840, was in lat. 26° 30′ S., long. 54° 22′ E. She had a strong E. by S. to E.S.E. wind, with "a high following sea," causing the ship to "roll heavily." Her course was W. ½ S.

On the 10th, in lat. 27° 13′ S., long. 51° 23′ E., the wind was E.S.E., blowing strong, with heavy gusts at intervals, dark clouds, and rain.

On the 11th she was in lat. 28° S., long. 48° E., wind variable; weather fine, and continued so till she got off the Cape of Good Hope.

At the Bellbouy, Port Louis Harbour, during this hurricane, a ship called the *Patriot*, was driven from her anchors on the 9th, and with the S.E. wind drifted to the N.W.; next day the N.W. wind carried her directly back, and threw her on shore, about a mile to the south of her former anchorage. The vessel was unmanageable, and, amid the thick of the storm, her crew knew nothing of whither they were driving, till they struck near the spot which they had left twenty-four hours before. Extracts from the vessel's log have been obtained, but too late for this part of the work; and as they are very interesting, in connection with what has been written before we saw them, they will be given in the Appendix.

THE MAURITIUS HURRICANE OF 1844.

(*No.* 26 *track on the chart.*)

The accounts which we have of this gale are not very complete, but are sufficient to enable us to recognise the outline of a rotatory action.

The *Tartar* was lying in Port Louis Harbour on the 1st January, when the wind was blowing a fresh breeze at N.E., with cloudy weather, and constant rain. The *Stag*, at the Bellbuoy, for sixteen hours, states that the wind was E.N.E. to east, which may be accounted for by her being two miles further out from the influence of the mountains than the *Tartar*.

On the 2nd January, the *Tartar*, in the same situation, had a strong N.E. gale, with constant rain, while the *Stag*, under weigh, and steering to the S.W., was six miles off the Morne, or Cape Brabant, (S.W. point of Mauritius) and had the same kind of weather with squalls, &c.

On the 3rd, the *Tartar*, still in port, had the wind N.E., and was, like the other ships in harbour, prepared in the usual way for the hurricane; while the *Stag*, in lat. 21° 45′ S., long. 55° 48′ E., had the storm at east to E.N.E., with heavy gusts, constant rain, &c. She was running W.S.W. and W. by S.

On the 4th, the hurricane at Port Louis was at its height, and veering from N.E. to N.W.; but, in lat. 23° 12′ S., long. 53° E., the *Stag* had a strong gale, which, in the course of twenty-four hours, veered from east to S.E. and S.S.E., "with a high sea, constant rain, and blowing hard."

On the 5th, the *Tartar* reports strong N.W. gales at Port Louis, and five ships on shore on the N.W. reef. On this day the *Stag*, had got as far as lat. 24° 13′ S., long. 52° 2′ E., with the wind moderating, at S. by E. to south, and the sky becoming clear, but a "high confused" sea continued during the twenty-four hours.

On the 6th, at Port Louis, the wind north, moderating. The *Stag*, in lat. 24° 58′, long. 48° 27′ E., had S.E. and variable winds, with occasional gusts, and a high sea, but saw nothing more of the gale.

In this storm the *Stag* was evidently in front of the gale, and left it behind, even crossing its apparent path; and is a further proof of the slow rate of progression on nearing the Tropics.

The centre would appear to have passed to the westward of Mauritius, and did more damage to the shipping in harbour by the force of the sea, than by that of the wind, which is described by an eye-witness of this and former hurricanes, to have been a "mere puff;" but was very severely felt at the island of Bourbon.

The following extract from the "Times," throws additional light upon the subject:—

"By the late arrivals from the Mauritius, the most painful intelligence has been received relative to a dreadful gale of wind that visited that island in the month of January last, during which, we regret to say, an Indiaman named the *Hugh Matthie,* 538 tons burden, and two emigrant ships, and two other vessels, were completely wrecked. Among the latter was the ship *Amity,* belonging to Liverpool, a very fine vessel, 600 tons burden, with 180 emigrants on board, besides the crew. The ship, which was quite a new one, sailed from Liverpool in the early part of June last for Bombay, and made a splendid passage. From Bombay she proceeded to the Mauritius with emigrants for the island, which place she reached in safety in the latter part of December, and remained in the harbour, in company with seven other vessels, until the hurricane broke forth. It appears from the letters received, that the storm commenced on the morning of the 3d of January, and immediately the master, Captain Wrightson, observed it approaching, he applied to the Port-office to obtain a pilot, in order to run the ship into the inner harbour, where she would be better sheltered; but none could be had, they having been engaged for the other vessels. As the day advanced, the wind increased greatly, with a heavy rolling sea, and by 9 o'clock there was a violent storm. The *Amity* had both anchors out with 140 fathoms of cable, in order that she might ride easily, but the violence of the sea worked her about in a most fearful manner; and frequently during the night the waves rushed along the decks, sweeping everything before them. At 11 o'clock, a large ship, which lay at the

Amity's stern, commenced firing minute guns, and discharging rockets and blue lights for assistance. One of the vessels that left Liverpool at the same time as the *Amity* did, unable to bear up against the storm, broke away from her anchors, and was hurled among the rocks. Two other ships shared the same fate. They were driven from their anchors, and were carried with terrific force on shore; and, unfortunately, these were also laden with emigrants, who had been shipped at Calcutta for the Island. The *Amity* weathered the gale until 8 o'clock on the morning of the 4th, when her cables were snapped by the force of a tremendous sea, and in an instant, in sight of thousands of persons, crowded along the coast, she was thrown upon the reef of rocks near the inner harbour, where every one on board would inevitably have perished but for the judgment and courageous conduct of the commander, Captain Wrightson."—*Times, 29th April*, 1844.

STORMS TO THE SOUTHWARD OF MAURITIUS.

Some of the gales already referred to in the preceding pages have been traced to the extra-tropical border of the trade wind, or probable place where they cease to have a determinate form or direction, and become stationary or uncertain in their movements. A few other cases may be added as illustrative of this:—

The *Windsor*, in 1836, during her homeward voyage, met in with a gale, as explained by the following extracts :—

Date.	Courses.	Winds.	Remarks.
Feb. 19	W. by S.	S.S.E. South.	A fresh gale, squally, heavy rain, and ship under close-reefed topsails. Lat. 25° 22′ S., long. 63° 11′ E. A heavy sea. Barometer 29.85, sympiesometer 29.25, thermometer 80°.
„ 20	W.N.W. N.N.W.	S.S.W. to S.W. and West.	Weather getting somewhat more moderate. Out second reef of topsails. Lat. 25° 25′ S., long. 60° 28′ E. Barometer 29.83, sympiesometer 29.42, thermometer 79°.
„ 21	W.S.W. S.W.	North. N.W. W.N.W.	The gale freshening; a heavy confused swell; ship labouring heavily. Split some sails. Lat. 26° 30′ S., long 58° 33′ E. Barometer 29.82, sympiesometer 29.35.
„ 22	N.W. W.N.W.	S.W.	Weather getting better. Lat. 26° 11′ S., long. 57° 55′ E. Barometer 30.7, sympiesometer 29.92.

This ship seems to have crossed the path of an advancing storm (track 27 on the chart), and although, by the fall of the barometer and sympiesometer, she must have been at a considerable distance from its centre, the wind veered in the usual manner. On the 20th, her course N.N.W. led her away from the storm, and the weather was better. Next day, running S.W. toward it, she again got into bad weather, and carried away some sails. On the 22nd, by steering N.W. she got clear of it altogether.

This vessel, in 1838, encountered a gale in the same place, and nearly similar in every way.

(*No.* 28 *track on the chart.*)

Date.	Courses.	Winds.	Remarks.
Feb. 17	W. ½ S.	N.E. N.N.E.	Threatening appearance: vivid lightning from S.W. to N.W. Hard rain. Three reefs in topsails; down top-gallant-yards. Lat. 27° 26′ S., long. 56° 44′ E. Barometer 29.86, sympiesometer 29.42, thermometer 81°.
„ 18	West. S.W.	North. N.N.W. N.W.	Under close-reefed topsails. Incessant rain; fresh gales; hard squalls. Threatening appearance. Lat. 28° 39′ S., long. 54° 11′. Barometer 29.79, sympiesometer 28.41.
„ 19	N.W. West.	S.W. W.S.W.	Weather moderating, and fine by noon. Lat. 28° S., long. 53° E. Barometer 30.9, sympiesometer 28.78.

On this occasion the *Windsor* would appear to have crossed behind the storm, and run through its northern half. As in the first case, when running S.W. she finds the gale increasing, and by steering N.W. gets out of it, there is reason to think that both these storms were very slow in their diurnal progression, from the fact of this vessel, on both occasions, being able to run up to and pass them.

We are in possession of records of other hurricanes met in with along the great track from India to the Cape of Good Hope, but in a work so limited as this it is impossible to give insertion to them. It is sufficient therefore to observe, that as far as we have examined them, they agree in every point in establishing the more important and prominent characteristics of the other revolving gales, which have just been referred to.

STORMS ON THE EAST SIDE OF THE INDIAN OCEAN.

It would appear that there is another locality near the N.W. coast of New Holland, between the boundaries of the trade wind and monsoon, in lat. 10° S., and long. 120° or 130° E., where the state of the aërial currents seems to be favourable to the formation of revolving gales, and from whence they move to the tropic by a curving course, coinciding with what may be called the middle track. Unfortunately, there is very little known about tempests in this part of the world, owing, perhaps, to the few ships that are crossing their path. The rise of our Australian colonies, and their increasing communication with India, and other places in the Indian Ocean, bring it within our province to point out spots where danger of this nature may be apprehended or perhaps avoided. At all events, it may pave the way for further and more satisfactory inquiry.

THE "MAGUASHA" HURRICANE.

(*No.* 29 *track on the chart.*)

The brig *Maguasha,* on her way from Swan River to Sandalwood Island, got into a storm of a rotatory kind, about the end of February, 1843,—a year famous for gales all over the Indian Ocean.

On the 27th February, this vessel was in lat. 18° 30′ S., long. 116° E., and the following extracts from her log-book show her subsequent course:—

Extracts from the Log of the Brig MAGUASHA.

Hours	K.	F.	Courses.	Winds.	Bar.	Remarks.
						28th February, 1843.
1	6	4	NE.by N	S.S.E.	29.70	Strong breezes and fair.
2	6	4				4h. P. M. Do.
3	7				29.60	6h. Freshening breeze. In
4	7					studding sails, and fore and
5	8					mizzen topgallant sails.
6	8				29.10	At 8h. fresh breezes and
7	7					squally.
8	7				29.	9h. Increasing breezes. In
9	7					second reef in topsails.
10	7					Midnight. Strong winds and
11	7					squally, heavy rain. Furled
12	7	4		South.	29.95	mainsail, stowed main-top-
						sail, yards on the caps.
1	7	4				Furled the foresail.
2	8				28.90	At 4h. A.M., freshening breezes.
3	8					At 6h. A. M. wind increasing
4	8				28.75	to a perfect hurricane. Fore
5	8		NE.byE.			and main-topsails gave way,
6	8					furled the remains, and
7	6					scudded under bare poles.
8					28.65	At 8h. still blowing and con-
9			NE.byE.	S.W.		tinued heavy rain.
10					28.70	At 10h. a heavy sea struck the
11						vessel and she broached to.
12					28.80	Noon. Do. weather and wind.
						1st March, 1845.
1	1	4	SW.by S.	W.N.W.	28.60	Begins with a heavy gale, and
			Off S.W.			continued rain.
			by S.			At 4h. do. weather.
5	1	4	W. by N.		29.80	6h. Much the same.
			Off W. by			At 8h. still blowing heavy, set
			S.			main-trysail close-reefed.
12	1	4	N.W. to		29.10	Midnight. Decreasing breezes
			W.			with heavy rain.
4					29.30	At 6h. moderate breezes and
						clear.
9					29.60	At 8h. light breezes with a
						confused sea. Under the
						remains of fore and main-
						topsails, and bent others. A
						strange sail in sight, and
						steering to the west.
						Noon. Moderate and fine.
						Lat. 16° 9′ S.

The probable track of this storm is laid down on the chart, where it will be seen to be perfectly conformable to all the others that have been described. The brig got into this storm in a very few hours, from the circumstance of running directly to meet it. It appears that on the 28th her course was about N.E. for 130 miles before she got into the vortex, and assuming that the diurnal progression of the latter to the S.W. by W., was similar to that of other hurricanes in lat. 16° S., or about 200 miles in twenty-four hours, it may be inferred that its semidiameter was 250 miles at least. Another circumstance strikes us as remarkable; the barometer fell from 29.70 to its lowest range in twenty hours; but in rising it took thirty hours to regain the same level. The explanation is obvious: the focus and the brig, in the first instance, were approximating each other, equal to the sum of both their rates of progression, but on separating, the mercurial column only ascended in the ratio of the departing movement of the former, as the latter being hove-to was not changing her position more than a mile an hour. The course of the *Maguasha* would appear to have led her across the track of the storm, within a few miles of the point of the vortex.

The present case satisfactorily shows that rotatory gales of a progressive kind occur near the west coast of New Holland. In the line which that of the *Maguasha* may, from analogy, be supposed to have followed in its course to the Tropic, we find by the following notes, that other vessels have suffered severely from storms, which, although we have no account of their real nature, may reasonably enough be considered as revolving like that just noticed.

On January 6th, 1812, the *Abercromby*, track 30 on the chart, a 1200 ton ship, was dismasted, and very nearly foundered in a gale, in lat. 14° S., long. 115° E. The wind began at north and veered to east and S.E., then suddenly chopped round to N.W. The storm, occurring in the same place as that of the *Maguasha*, was, no doubt, similar in other respects.

The *Ceres*, in 1839, when in lat. 21° S., long. 112° E., encountered a storm in which she lost her masts.

Colonel Reid notices the *Bridgewater* having met with a hurricane, veering from N.E. to N.W., on the 4th Jan. 1830, in lat. 21° S., long. 90° E., and from its effects it appears to have been of a severe kind.

The following extract from the "Morning Herald" of Nov. 3, 1843, informs us of a hurricane near Timor, nearly in lat. 10° S., long. 124° E.

TIMOR HURRICANE OF 1843.

(*No.* 31 *track on the chart.*)

"Batavia, June 30th.—From 12th January to beginning of February, violent N.W. winds prevailed in the Molucca seas, and did some damage in Amboyna to the Government buildings, and rendered the communications between the islands exceedingly dangerous.

"Accounts from Timor, of the 17th May, say that on the night of the 21st April there was a terrible hurricane, which was especially destructive in the Island of Rotty. Vast numbers of trees were blown down, and great damage was caused by the blowing down of large lofty trees where the bees breed, so that it is believed no wax can be collected for two years. A great number of houses were thrown down, and seventy-five persons lost their lives, among whom were the wife and daughter of the Rigih of Talay. In Timor some trees were thrown down, but the damage was not so considerable."

Supposing the *Maguasha* hurricane, as it came from the N.E. was formed near Timor, and in its course to the S.W. followed a curving direction to the Tropic, similar to that of the Rodriguez, it would nearly embrace the situations where the above-named vessels fell in with storms.

At Mauritius, information may probably be collected on this interesting subject, as vessels, on sustaining severe damage in the eastern part of the Indian Ocean, generally run before the trade wind to that island to refit.

HURRICANES IN THE MOZAMBIQUE CHANNEL.

THE "MALABAR'S" STORM OF 1840.

(*No.* 32 *track on the chart.*)

In January, 1840, the ship *Malabar* encountered a hurricane in the channel between Madagascar and Africa, which has all the character of a vortical storm, moving in the usual direction from about E.N.E. to W.S.W. The following observations are obtained from her log-book.

Extracts from the Log of the MALABAR.

Hours	K.	F.	Courses.	Wind.	Bar.	Remarks.
						January 22nd.
			S. by E.	W. by N.	Bar. 30	Calm. 7h. 30m. P.M. a sharp squall W.N.W., with much lightning. Lat. 13° 18′ S., long. 41° 21′ E.
			S. by W.	W. by N.	Ther. 85°	
A.M.						January 23rd.
1			S. by W.	W. by N.	29.80	Threatening appearance; dark cloudy weather, and sharp squalls. Two reefs in the topsails.
2						
3						
4						
5						
6			S.W. to S.		29.80	
7						
8						
9						
10						Lat. 14° 35′ S., long. 42° 8′ E. Course south, 32° E., 91 miles.
11					29.75	
12						
P.M.						
1						
2				S.W.	29.70	At 1h. 30m. hard squalls, with heavy rain.
3					Ther. 85°	

Extract from the Log of the MALABAR (*continued*).

Hours	K.	F.	Courses.	Winds.	Bar.	Remarks.
4				South.		
5				S.S.W.		At 5, close-reefed the topsails.
6					29.60	Sunset, blowing a heavy gale.
7						Sent down royal yards.
8				S.W.		
9					29.50	A high sea and much lightning.
10						
11				W.S.W.		
12						
A.M.						January 24th.
1	2		N.W. to	W.S.W.	29.50	Incessant rain with heavy sea, down top-gallant yards. 3 A.M. wore ship.
2	2		W.N.W.			
3	2					
4	4		S.W.	N.W.		At 4 A.M., tremendous heavy squalls. Furled the topsails, housed top-gallant-masts, &c. &c.
5	4					
6	3				29.40	
7	4		South.	N.N.W.		
8	4		N.W.			Pitched away jib-boom.
9	4				29.40	At 7 A.M., almost a perfect hurricane. Ship labouring much, and shipping a great deal of water.
10	4		S.W.¼W.	North.		
11	4					
12	5					
P.M.						At 10 A.M., blew a perfect hurricane. Hove the ship to under bare poles.
1	5			N.E.		
2	6		W.S.W.		29.50	
3	6		West.			Lat. 14° 46′ S., long. 42° 31′ E.
4	8		SW.byW		29.56	The wind veering gradually round the compass from S.W. to W.N.W. and N.E.
5	8					
6	8					
7	9					3 P.M., gale moderating.
8	9				29.60	
9	9					
10	9					
11	9					Midnight, hard squalls and heavy rain.
12	9				29.60	
A.M.						January 25th.
1	10		SW.byW	E.N.E.	29.60	Looks wild: shipping broken seas over all.
3	10					
7	9		S.W.	E. by S.	29.65	
9	8					Gale moderating.
P.M.						
1	9		SW.byW	E.N.E.	29.65	Lat. 18° 15′ S., long. 40° 16′ E.
3	9				Ther. 80°	
4					29.70	
12					29.70	

Here is a storm, evidently of a rotatory kind, but in a situation different from those already examined. Yet, as in those other cases, the direction of its movement, rate of progression, &c. are perfectly conformable to those of the Rodriguez, and other storms, when in the same latitude, and also to that of the *Maguasha,* on the opposite side of the Indian Ocean. Uninfluenced by the land on either side, the vortex appears to have moved across the Mozambique Channel by a W.S.W. course (true S.W. by W.) The *Malabar* would seem to have been running into the northern side of the storm's circuit, and had the centre passing across her course down the Channel. As long as the vessel was not making much progress, the gale was nearing her, and the barometer gradually went down, till the vortex was past; and it would most probably have risen in the same manner had she lain-to. But no sooner was the storm round to N.E., and became a "fair wind," than she commenced running S.W. by W., almost parallel to its course, and for twenty-four hours more was in a severe gale. And what is still more remarkable and instructive, the barometer remained at about 29.60 for twenty hours, while the vessel was scudding nine and ten knots an hour. If any thing could satisfactorily show the rate of progression of a storm, it is this case of a ship sailing alongside of the storm's centre, and keeping within the same relative distance of it for twenty hours. The same circumstance, however, has occurred in other cases, but in a less remarkable degree.

THE "BOYNE'S" STORM.

(*No.* 33 *track on the chart.*)

Recorded in the "Law of Storms," appears to have occurred in the very same position as that of the *Malabar,* and at the same time of the year;—and is in some degree conclusive with regard to the opinion that storms pursue certain lines. It is surely something beyond mere accident that brings under view two storms in the same locality in the Mozambique Channel; and those of the *Maguasha* and *Abercromby*, near New Holland.

It appears that about the time of the Boyne gale, a vessel encountered such weather to the eastward of Madagascar, as to lead Colonel Reid to infer that it came from that direction, and of course crossed the island. This is exceedingly probable, and would create a supposition that the storms of the Mozambique Channel are formed at the north-east part of Madagascar, somewhere about lat. 10° S. That their source is not much farther to the eastward is rendered likely by the fact that tempests are absolutely unknown at the Seychelles group of islands.

SECTION V.

CIRCUMSTANCES CONNECTED WITH THE FORMATION OF ROTATORY STORMS IN THE INDIAN OCEAN SOUTH OF THE EQUATOR.

We are thus acquainted with a succession of storms, of a peculiar kind, which have swept over certain tracts of the South Indian ocean, and left behind a train of memorable disasters. If we are right in the conclusion that they depend on the periodical laws which control the revolving seasons, it is to be expected that they will revisit the same latitudes with equally destructive consequences to such vessels as may unhappily be exposed to their fury. It is hoped, therefore, that no apology is necessary for an attempt to explain their nature, in order to arrive at the means of averting the calamities consequent on their recurrence.

In the preceding sections it is shown that the greater proportion of hurricanes in the region to which we refer may be traced to the neighbourhood of lat. 10° or 12° S., and near Sumatra, Java, and other islands, stretching away to the eastward in the same parallel; and that, with little deviation, they have followed a common track to the S.W. It is further demonstrated, that they are vast whirlwinds, revolving from east by south to west, in accordance with the views of Mr. Redfield and Colonel Reid. It is satisfactory to reflect, that the more complete our information is with regard to a particular storm, the more fully is this point established. It is only in the instances of single ships that any doubt can possibly arise on this head, and even in these we have seen that the majority concur, to a remarkable extent, in supporting the rotatory principle. In the Rodriguez storm, the evidence adduced in favour of this is, in our humble opinion, almost irrefragable. There is scarcely a day from the 1st to 9th April on which this is not manifest. Each day is a separate fact, and a consecutive chain of these is linked together in such a manner that each adds corroborative testimony in support of the correctness of its predecessor.

Allowing, what in all probability is the case, that some errors have crept into our calculations, or existed in the information from which the inferences are drawn, it is hardly possible to suppose that they have all occurred on one side. At least, it may be granted, that they correct each other; but, if we put the doubtful facts out of the question, there are enough remaining to confirm the opinions and results which are given.

From the absence of a more complete and extended system of observation on storms than that which we possess, not only many difficulties present themselves at the outset, but fresh obstacles start up at every step, in the investigation of this intricate subject. In producing these strange commotions of the atmosphere, a variety of agencies appear to co-operate. Among them, we may mention the action of heat, and its allies, electricity and light, (the latter perhaps in a subordinate degree,) the laws of gravity, the revolution of the earth on its axis, the effects of vapour during its suspension in the atmosphere, and the changes which it undergoes when condensation takes place; and, finally, the new and distinctive laws acquired by, and which govern, a body of air in circular motion round a focus progressing with a greater or less degree of speed. To investigate the complex operations arising out of an apparent combination of all, or even a few of these powers, is a task which offers little encouragement, and it may be considered as temerity in one who has hitherto only paid a very limited attention to meteorology to attempt it. The condition of the upper regions of the atmosphere is a point of great importance to be known, and is likely to elude our inquiries for a long time. The state of air, in its union with vapour and electricity, seems to be more intimately connected with a rational solution of the question, than the simple assumption that one or other of the two last are the sole cause. Our present object is to arrange the phenomena which are developed during a hurricane, in what seems to be their proper position, as primary causes, or as effects exercising a subordinate and re-active influence on the process from which they derive their origin. From the very nature of the inquiry, it is impossible to divest it of much hypothetical reasoning, and reference to principles which are not yet definitely fixed, and only accepted in a limited degree. Truth, however, is what we seek, and if nothing new is brought forward, we may hope to confirm some hitherto rather doubtful points which have been propounded on the subject of storms.

Before entering more directly into the investigation before us, it may not be out of place to recall a few first principles of meteorology, which must be borne in mind throughout, as being essential to the elucidation of the inferences which have been deduced.

The atmosphere which surrounds our globe is generally supposed to be about 45 or 50 miles above the level of the ocean, and, in its ordinary condition, exerts an equal pressure at every point of the earth's surface. This pressure amounts to the weight of about fifteen pounds on the square inch, and is capable of supporting a column of mercury thirty inches in height. The density of the air diminishes from below, upwards, in a geometrical ratio, so that, at the elevation of three miles above the level of the ocean, the barometer or mercurial column will fall to 15 inches, and at six miles to 7½ inches, and so on. It therefore follows that half the whole mass of atmosphere is within three miles of the earth, or nearly so. It is also found that the temperature of the atmosphere decreases from below upwards in a regular gradation, or, more correctly speaking, the sensible heat unites with the air, and assumes the latent form. In a quiescent state this process is regulated throughout the whole height of the column by the degree of heat at the base. When air is heated, its bulk proportionately increases, while its specific gravity is diminished; it becomes rarified, and acquires a tendency to ascend, or rather, in obedience to the laws of hydrostatics, it is forced upwards by the lateral pressure of the surrounding cool and heavier masses.

Near the equator, the mean temperature at the surface of the earth is nearly 80°, while within the polar regions it seldom exceeds 32°, or the freezing point, and is generally far below this. This difference is attended by a corresponding inequality in the weight of a given bulk of air at the two places. But as the superincumbent pressure of the whole atmosphere is found to be equal at both points, it necessarily follows that at the former, owing to its higher temperature causing it to occupy more space, it must be considerably higher than at the latter. This elevation is further assisted or increased by the centrifugal action of the earth, caused by its diurnal rotation. The upper surface of the atmosphere will thus represent two planes, inclining from the equator to the poles.

A direct consequence ensues from this state of things in producing an atmospheric current from the colder to the warmer locality at the level of the ocean, counterbalanced by another and opposite one in the higher regions. Taking Professor Daniell's calculation as the simplest and best which we know,* we find it stated, that as the temperature of the atmosphere at the equator, on the level of the earth, is 80°, its specific gravity is only ·90000, whereas, at the poles, supposing it to be at 0, its density will be equal to 1·0666; an excess of gravity is thus established at the latter place, with a perpetual tendency to press onward to the point of least resistance. In fact, the quantity of atmosphere within three miles of the surface of the globe, near the poles, being heavier than that at the equator, the laws of gravity will force the former under the latter, exactly in the same manner as water placed at one end of an oblong vessel would quickly penetrate beneath a quantity of oil or lighter fluid at the other. On the other hand, the excess of atmosphere in the upper strata, near the equator, over that of the polar regions, will, in obedience to the same laws, constantly tend to flow towards the latter. The lower, or polar current of air, on approaching the tropical latitudes, is gradually receiving accessions of heat, so that when it arrives at the hottest region of the earth, it acquires a vertical motion to a certain elevation, whence it flows back to the colder regions, yielding up its latent heat in a sensible form as it sinks downwards, and, in the temperate zones, reaches the level of the earth as a bland and genial west wind.

As heat is the chief, if not sole agent in creating this continuous interchange of the atmosphere between the hot and cold parts of our globe, by means of a superior and inferior current, so we have another, and perhaps equally important, force to consider. From the diurnal rotation of the earth acting more directly on the solid parts of the globe, the aërial masses by which it is surrounded are, to a certain extent, left behind, so that while the earth is moving eastward, the atmosphere appears to have an opposite direction. Hence the polar currents flowing to the equator are by this means caused to deflect in an easterly, or rather a N.E. direction, on one side of the line, and S.E. on the other. As the effect of the earth's revolution is greatest at the equator, and diminishes towards the poles, its operation is in a great measure confined to twenty-six or twenty-eight degrees on both sides, embracing the tract occupied by the regular or trade-winds. Beyond the latitudes of 30° N. and S. the atmospheric currents are variable, or principally from the westward, and, as we have said, are supposed to be formed by the higher current of the tropics sinking down to the level of the earth, and carrying with it so much of the easterly motion received at the equator, as to give it a great excess over the slower rotation of the solid parts of the globe at this point.

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* Daniell's Meteorological Essays, page 18.

Such, we believe, are the commonly received opinions with regard to the causes of the trade-winds, and general currents of the atmosphere, since the time of Hadley. It seems, however, that some meteorologists of the present day still controvert the important influence of heat at the equator, in producing an ascending current, in its vicinity, to form the great equatorial wind above, and in a counter-direction to the trade-winds. The fact of an upper current existing is so satisfactorily proved, that it seems to be scarcely necessary to advert to the decisive arguments which support it.

If we allow that the rotation of the earth on its axis is the sole cause of the trade-winds, we should naturally infer that their force would be greatest at the equator, and their direction due east. This is opposed to experience; for it is well known that in the neighbourhood of the equator there is a tract of ocean which lies between the two trade-winds, characterized by calms, and light, variable, or west winds. This space extends from Africa to America, in the Atlantic, and is from six to eight degrees in breadth. It is also found that the trade winds are more easterly in their direction near the tropics; and as they approach the interval of light winds they gradually deflect towards the equator, and, at the same time, become weak and uncertain, so that the N.E. trade veers to north, and the S.E. trade to south; thus blowing at right angles to the direction which they ought to have, if under the influence of the earth's revolutionary movement at the point where its velocity is greatest.

The very name of "calms," applied to the region in question, indicates an absence from lateral and horizontal currents to any remarkable extent. As the two winds which bound this space blow directly into it, it argues that there must be some way for such a continuous accession of atmosphere to escape, else an accumulation would necessarily take place, and an elevation of the mercurial column be the result. For instance, let us suppose that the tract lying between the two trades represents a parallelepoid of forty degrees long and eight broad, between the Cape de Verde Islands and the West Indies, into which the opposite trade-winds, or lower strata of the atmosphere, to the height of three miles, enter from both sides, at the rate of 20 miles per hour, that of a gentle breeze; if no up-current existed, the only lateral channel open for the efflux of the air would be the eight degrees at either extremity, where the wind would constantly blow with a velocity of 100 miles per hour, or that of a violent storm. But supposing the effects of the rotation of the earth opposed this at the eastern extremity, the current flowing out at the opposite point must be increased to the enormous rate of 200 miles per hour, exceeding that of the most tremendous hurricane! If we turn to the Pacific Ocean, where the "calms" form a mere band, reaching from America to the Indian Archipelago, into which the regular winds at the surface of the earth blow from both sides, the reasoning which has been adduced applies with much greater force. Nothing, in fact, but an ascent of air at the equator is adequate to explain the circumstance to which we refer.

Allowing the mass of air subject to the motion of the trades to extend for three miles above the sea, and to enter the equatorial tract in question, at twenty miles per hour, it would only require three miles of latitude to assume a vertical motion of the same velocity as that which it previously possessed. Or supposing this upward direction does not exceed one mile per hour, the whole stratum will have risen above the level on which it approached the equator within the distance of sixty miles. But as the tract of variables is eight degrees in width, this new motion of the atmosphere must take place in a still more gentle manner. Nor is it probable that the whole of the lower stratum arrives at the "calms" without acquiring an upmoving force. Indeed, from the gradual abating of the strength of the trade winds at their equatorial border, there is reason to think that certain portions of the atmosphere begin to rise some time before they cease to be perceptible on the level of the earth.

Every one acknowledges the agency of heat in generating local currents in the atmosphere, or what are called land and sea breezes; why, therefore, should its influence on the general currents of the globe be objected to? The difference of temperature on the surface of land within the tropics, between the day and the night, seldom exceeds 30° or 40°, but between the poles and equator it is at least equal to 80°. It is true that the dry surface of an island is capable of raising the temperature of the air in contact with it far above that which would be produced by the same extent of the ocean, and that, by this increased rarefaction, it would acquire a greater tendency to ascend; but, we suspect, that this is little more than equivalent to the additional impetus which the vertical current of atmosphere at the equator must receive from the elastic force of vapour, constantly rising from the sea, at the greatest thermal band of the earth. It will be no easy task to explain on any other known principle than that of calorific action, the existence of the equatorial zone of westerly winds, which embraces the globe and follows the annual movements of the sun.

So far we have considered the space separating the trade-winds of the two hemispheres as being stationary, and near to the line. This, however, is not exactly the case, for the periodical movement of the sun from one tropic to the other is productive of certain changes which require to be noticed, and are, to a certain extent, corroborative of what has been said with regard to the agency of heat on the great and permanent currents of our atmosphere.

It is well known that as the solar influence approaches the northern tropic, the N.E. trade becomes feeble, and recedes for several degrees farther from the equator than during the winter season, and the interval of "variables and calms," or what may be called the greatest thermal band, is carried in the same direction. At the same time the S.E. trade of the opposite hemisphere is increased in strength, and even extends its sway for four or five degrees north of the equator; but as it takes some time for the heat to accumulate, these changes rather *follow* than accompany the course of the sun. In the same manner, as this luminary returns to the equator with a motion increasing till he has passed into the opposite tropic, the tract which is left behind gradually becomes lowered in its temperature, the dense air from the arctic region presses onward, and the trade-wind regains its force, and re-occupies its natural position.

A corresponding series of alterations in the state of the atmosphere and its currents, is caused by the movements of the sun to, and retreat from, the southern tropic. Hence there is an annual fluctuation of the sub-solar band of the atmosphere, and "vertical winds" from one side to the other of the equator; with this difference, however, that as the sun is somewhat longer in the northern than the southern hemisphere, and the former is, for this and other reasons, comparatively higher in temperature, the great thermal zone does not advance so far into the latter region.

We have been almost forced into these remarks, because it is in the tract of "variables," lying at the equatorial edge of the trade winds, that we believe the source of the great progressive hurricanes of the tropics is to be found, at least it is so in the southern hemisphere.

Now, in the Indian Ocean, directly connected with our subject, the general effects of the calorific agency of the sun, which have just been mentioned, are greatly modified and altered by the local influence of land. It is in fact a vast basin, with Africa on the west, Asia to the north, and the Indian Archipelago and New Holland on its eastern boundary; and is only open to the southward, where we understand its limits to be a line from the Cape of Good Hope to Bass's Straits in 34° S.

When the sun is over these continents, the air in contact with their surfaces becomes heated, acquires an upward motion, and is replaced by horizontal currents of the atmosphere from the cooler localities in their vicinity, which in their turn oppose, disturb, or divert from their natural course those subject to the more fixed laws of the universe. The changes effected in this way are so varied, and dependent on so many subordinate circumstances of an accidental nature, as to baffle any attempt to give a concise account of them in a work of this kind. This is well exemplified in the case of the monsoons north of the equator, which alternately blow with a strength and periodicity equal to the more permanent and normal currents of the trade-winds. It is further to be recollected that the same causes which give rise to the monsoons, exist in a more limited degree on every spot of land scattered over the Indian seas, and are liable to produce derangements of the atmospheric currents proportionate to their size, position, and the season of the year.

Having premised these brief sketches of the local and general consequences of solar influence, and the rotation of the earth on its axis, on the atmosphere, we may proceed to inquire how far their operation is traceable in its stormy commotions.

The season in which hurricanes occur in the Indian Ocean, south of the equator, is generally considered to extend from December to April, or hottest months in that hemisphere. Those with which we are acquainted have taken place in the following order:

November	1.—on the 21st, *Albion's* storm.
December	3.
January	10.
February	16.
March	17.
April	10.
May	1.—on 3d May, *Exmouth's* storm.

During the rest of the year tempests are unknown. The trade-wind occasionally prevails, in the winter months, to the extent of what may be called a fresh gale, but can neither be compared to the terrific force of the hurricane, nor is it marked by much change in its direction. Thus, finding that rotatory storms are confined to a certain period of the year, which commences about the time when the southern hemisphere has arrived at its greatest pitch of annual temperature, and continues during the retrograde movement of the sun to the equator, or even a few weeks later, we are naturally led to investigate the meteorological condition of the atmosphere at this time, and to endeavour to discover to what extent they are influenced by it.

The S.E. Trade-wind.—During the winter, or cool months of the southern hemisphere, which may be reckoned from April to October, the trade-wind blows with great strength and steadiness over the South Indian Ocean, up to the very Line, or within one or two degrees of it. As soon, however, as the sun recrosses the equator from the northern tropic, and the atmosphere begins to acquire additional temperature, a new state of things takes place. The regularity and force of the trade-wind begin to fail, and as the solar action increases, it soon dies away altogether, or recedes from the equator as far as lat. 10° or 12° S., where its northern limit is established during the hot months of the year. At the same time, however, its southern border extends considerably beyond the tropic of Capricorn, to about 26° or 28° S., sometimes even beyond 30° S.

The Westerly Monsoon.—The alteration which the trade wind undergoes in its position is followed by another, and equally curious change, apparently induced by solar agency. The tract of ocean from the equator to 10° S., from which the S.E. trade retires, is occupied by a new aërial current, in a direction exactly opposite, and called the westerly, or N.W. monsoon.* This wind usually sets in about November, and begins to decline in March or April, and extends from the east coast of Africa to the Indian Archipelago and New Holland. Its direction near the equator appears to be about west to W.N.W., but at its confines next the trade in lat. 10° S., it becomes N.W., yet of course subject to many variations of a few points on one side or the other.

Near the coast of Africa this westerly wind extends farther from the equator, and in its different variations from S.W. to N.W., and even north, it generally reaches as far as Bourbon and Mauritius, where it may be considered as the prevailing wind from December to March. Something of the same kind appears also to take place near the northwest part of New Holland. The heated air rising from the surface of this low, sandy continent, when the sun is over it, causes the westerly monsoon in the Molucca seas to blow towards it in a direction from N.N.W. to N.W.; and at the same time the S.E. trade, for some distance from the coast, deflects to south and S.W., till it rushes directly towards the same locality. The consequence is that the monsoon is found less distant from the equator, near the middle of the Indian Ocean, than at the great continents at either side. It would also appear that the trade-wind, during the solstitial season, approaches nearer to the equator at this point, as if forcing itself into the monsoon. This is more particularly the case between long. 80° and 90° E.

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* The Line—westerly-monsoon of other parts of the globe.

In laying down the line of demarcation between the S.E. trade, and the westerly monsoon, at the season of the year when the sun is near the southern tropic, we do not mean to say that it is always the same, but merely that such is the mean position, yet, of course subject to variation from a number of disturbing causes which we are ignorant of, or can only suspect to exist as well in the upper regions of the atmosphere, as on the surface of the earth.

It is asserted that the cause of the westerly monsoon is the ascent of rarefied air from the continent of New Holland, but it seems to be very questionable whether this is sufficiently extensive to draw a current of air across the Indian Ocean from Africa, in opposition to the effects of the earth's rotation. In fact, the S.E. trade is only diverted from its ordinary direction, for a few degrees to the westward of the land. Nor does the influence of the Indian Archipelago appear adequate to the explanation of this new and periodical current.* The African continent ought, on the same principle, to give rise to a similar wind, *in cœteris paribus*, in the South Atlantic Ocean. Theory would lead us to expect that the solar action on the east coast of Africa and Madagascar, when conjoined with the momentum caused by the known effects of the revolution of the earth on its axis, would be productive of an atmospheric current of no ordinary velocity from east to west, yet we find it exactly the reverse. A wind blowing within ten degrees of the equator for six months, in direct opposition to these forces, is a grave objection to the theory that heat does not affect the *general* currents of the atmosphere.

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* The westerly monsoon is known to extend as far to the coastward of New Holland as Tahiti.

The prevalence of this monsoon is scarcely reconcilable to any other agency than that of heat. This is sufficiently obvious from every fact connected with the subject; but the precise nature of the proximate cause is by no means very evident, and admits of ample scope for conjecture. Allusion has been made to the sub-solar zone, lying between the trade winds of the two hemispheres, and to the vertical motion which air assumes in this situation. It would seem that in the Indian Ocean the movement of the sun towards the southern tropic carried this great thermal-band along with it as far as 10° or 12° S., displacing the trade-wind for a time, and giving rise to the new current blowing obliquely from the equator into this tract, where, during the solstitial season, the maximum degree of temperature and ascent of air is to be found. From the properties and direction of the N.W. monsoon, and its probable connexion with the vertical currents of the atmosphere during the season peculiar to hurricanes in the South Indian ocean, we may conclude that about 10° S. it acquires an upward direction, and forms, or at least joins and adds its impetus to, the higher or equatorial current flowing towards the poles.

It is very doubtful whether the influence even of Africa or New Holland extends more than a few degrees from their shores, or is even accessory, in any remarkable degree, to the creation and continuance of an atmospheric current extending over 4,000 or 5,000 miles of open ocean. It is not impossible that the force of the vapour ascending from the ocean, at the high temperature peculiar to the season, over the tract of the monsoon, may add considerably to its velocity and tendency from the equator. The enormous quantities of water raised from the surface of the sea by continued evaporation, at about 80° of Fahrenheit, can hardly be supposed to force its way through the molecules of air without conveying to them a greater or less degree of motion. The subordinate agency of vapour will increase as the density of the atmosphere is diminished; hence, in the upper strata of air, near the equator, it may have a much greater influence than is generally suspected.

Thus we have two great winds blowing, in contrary directions, from one side to the other of the Indian Ocean, between the equator and the tropic, the one depending on fixed and permanent laws, and the other, periodically called into existence by agencies of a temporary duration, exerting an almost antagonist force to the former. As the solar action takes place in a gradual manner, the recession of the trade wind, and establishment of the monsoon, follow in a corresponding degree: the sky is serene and clear, indicating an increasing temperature in the upper regions of the atmosphere, and a rising dew point. But, as soon as the sun begins to leave the tropic, and the heat to decline, the changes contingent on the subsidence of the monsoon take place in a sudden and unequal manner, and it would seem often give rise to those fearful conflicts of elementary forces which form the subject of our present inquiry.

Between the two winds in question, about lat. 10° to 12° S., there is an intervening space of several degrees of variable and light winds or calms, distinguished by an unsettled state of the atmosphere, exactly similar to that which occurs between the S.E. and N.E. trade winds in the Atlantic. In approaching this tract, the S.E. trade deflects to south, and the westerly monsoon to N.N.W. or north. At the meeting of these currents of air, or rather in the neutral interval, sudden squalls, lulls, thunder-storms, and heavy rains, are usually experienced. This is to be expected from the very different conditions of the two winds, for they are not only diametrically opposite in their direction, but as dissimilar in reference to their respective temperature, humidity, and specific gravity, as it is well possible for two neighbouring masses of air to be; so much so, that a few remarks on the subject seem to be necessary.

The S.E. trade-wind at Mauritius prevails for about eight months in the year, or about 230 days, that is, in all its variations from south to east. In June, July, August, and September, it blows almost uninterruptedly, in strong steady breezes. In October it begins to wane, and alternate with N.W. and north winds. During the height of summer it is only experienced for a few days at a time, is squally, and usually preceded by heavy rain as it sets in, and seems to possess peculiar properties, as contrasted to the prevailing monsoon at this period.

When this wind is fairly established, the atmosphere becomes less humid, the barometer rises about .20 or .30, and the temperature becomes lower by three or four, or even more degrees. The sky becomes clear and serene, and marked by light, well defined cirro-cumulous clouds, floating along with the lower current, while an opposite drift may generally be perceived in the higher regions of the air.

The limits of the monsoon, and season when it prevails, have already been noticed; it therefore only remains to consider the peculiarities which distinguish it from the trade-wind. As we have already said, the monsoon, varying from N.W. to N.E., extends its influence as far south as Mauritius, and from December to March, may, with the exception of intervals of the S.E. trade, be considered as the prevalent wind. During this period, the mercurial column stands, on the average, about .40 lower than in the cool season: the mean temperature is also greatly increased, and the dew point rises nearly in the same proportion. At the same time, the quantity of water suspended in the form of vapour throughout the atmosphere is at its maximum, and is nearly one-third greater than during the opposite season, and more than half the whole quantity of rain for the year is found to fall.

The annexed Tables B and C, exhibit these results in a more compact form. By reference to these, it will be seen that a constant relation exists between the height of the barometer, the increase of temperature, and proportion of vapour absorbed by the air. The extent of the maximum depression of the barometer observed for so many years, when the sun is nearly vertical, cannot be ascribed to any accidental circumstance, but to causes which annually recur. The same thing, however, is ascertained to

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TABLE B.

An ABSTRACT from METEOROLOGICAL OBSERVATIONS made by COLONEL LLOYD at the OBSERVATORY of PORT LOUIS, during the years 1833, 1834, and 1835.

Months.	Mean range of the barometer.			Thermometer in the shade — Mean.	Dew Point. — Mean.	Quantity of water in a cubic foot of atmosphere — In grains	Quantity of rain which fell. — Inches.
	Max.	Min.	Mean.				
January	30.189	29.593	29.859	81.96	74.10	9.343	8.453
February	30.199	29.769	29.899	81.66	75.13	9.669	5.126
March	30.221	29.988	30.103	82.66	75.43	9.650	5.916
April	30.265	29.927	30.063	82.63	75.70	9.650	5.446
May	30.328	30.062	30.203	77.20	69.66	7.911	6.233
June	30.407	30.099	30.238	76.50	66.72	7.305	.516
July	30.409	30.165	30.256	73.93	62.37	6.574	.830
August	30.399	30.199	30.200	74.60	64.10	6.855	1.460
September	30.398	30.165	30.230	75.70	64.41	6.860	.676
October	30.370	30.101	30.269	76.43	75.40	9.733	1.186
November	30.236	30.114	30.222	79.20	70.06	8.248	2.536
December	30.235	29.950	30.285	81.86	73.80	9.060	8.860

The quantity of vapour in the atmosphere is computed from the mean temperature and mean dew-point.

TABLE C.

An ABSTRACT of METEOROLOGICAL OBSERVATIONS made in the ISLAND of MAURITIUS from 1840 to 1842 inclusive.
The two first years at SOUILLAC, and the last at PORT LOUIS.

	Months.	Mean height of the barometer at 9 A.M. and 3 P.M.	Thermometer.		Grains of water contained in a cubic foot of air.	Tension of vapour.	Evaporation from a disc of 6 inches in diameter	Prevailing winds.		Remarks.
			In the open air at 9 A.M. and 3 P.M.	Within the Hygrometer at 9 A.M. and 3 P.M.				Northerly and N.W to W	SE. trade wind S. to E.	
Hurricane season.	January ..	29.900	84.60	76.	9.954	0.936	1.45	17.	10.3	Hot, oppressive, heavy rains, thunderstorms and unsettled weather.
	February ..	29.950	84.50	76.50	9.954	0.936	1.45	18.	10.	Do. do.
	March......	30.050	82.45	75.50	9.786	0.906	1.18	16.	15.	Do., squally and tempestuous at times.
	April	30.060	81.	73.50	9.060	0.849	1.29	11.	19.	The cool trade-wind acquires strength.
	May	30.100	78.50	70.	8.264	0.770	1.18	6.	20.5	Season gets cool, light showers.
	June	30.130	75.35	67.	7.746	0.699	1.09	3.	27.	Strong S.E. winds, cool and dry.
	July........	30.150	72.	64.61	6.914	0.636	0.96		31.	Do. do. veering to South.
	August	30.190	73.40	66.13	7.346	0 678	0.90	6.	25.	The trade-wind in fresh gales at S.E. to S.S.E.
	September ..	30.080	75.64	67.84	7.545	0.699	1.09	3.	27.	Very fine, dry clear atmosphere.
	October	30.070	80.78	70.78	8.232	0.770	1.54	12.	17.	Do. trade-wind failing.
	November	29.900	81.50	71.64	7.948	0.796	1.57	18.	12.	Do. calms, light north and N.W. winds, heavy showers.
	December ..	29.800	83.50	75.30	9.625	0.906	1.39	18.	11.	Do. but sultry, occasional heavy rains.

In this Table the quantity of vapour in the atmosphere is calculated from simultaneous observations of the dew point and external temperature of the air.

be the case in all tropical regions, where attention has been given to it. The diminished pressure of the atmosphere, indicated by the barometer, when it contains a greater degree of moisture, or additional increments of heat, can only be explained by the specific gravity of air decreasing as its temperature increases. Nor is the effect of vapour, at the tension of 80°, in lessening the weight of the atmosphere to be overlooked, although this will in some degree depend on the quantity existing in the higher strata of the air. According to Professor Daniell, the alteration produced in a given quantity of air by a temperature of 80°, and the elastic force of vapour at the same rate, would reduce its specific gravity to .9011, supposing air at 32° to be equal to a 10,000.* By the same table we find that, as the mean temperature at Mauritius in the winter is above 60°, its specific gravity would, when charged with humidity, be .9341, or .033 of greater density than during the hot months, and would raise the mercurial column in the same ratio. Perhaps the increased elasticity derived from these sources may be equivalent to the loss of pressure, by resisting, in a lateral direction, the heavier columns of atmosphere under the influence of the S.E. trade. Or, what is not unlikely, the cool and dense S.E. wind, in approaching the calm and hot tract intervening between itself and the monsoon, rapidly imbibes heat and moisture, and thereby acquires an ascending motion.

As usual, when heat and vapour are combined with the atmosphere in a high degree, they appear to call into existence a new and conspicuous element, nearly allied to, if not absolutely a modification of, the former—we allude to the copious evolution of electricity, which is one of the most remarkable phenomena connected with the monsoon. It is very rare to see lightning with the S.E. trade, unless in those commotions where it is commingling with the N.W. wind.

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* Meteorological Essays, page 180.

Nothing is more characteristic of the monsoon than the dark, gloomy, or overcast state of the sky. It seems as if a hazy, unbroken canopy of thin cloud was drawn over it, not sufficient, generally speaking, wholly to arrest the passage of the sun's rays, but tending to give them a great degree of refraction; and the air is ascertained to be nearly saturated with vapour at the time. Yet, unless the wind changes to the S.E., very little rain falls, except in sudden and brief showers, during which it is precipitated in torrents. Towards evening, the broken rays of light produce those wild, unnatural, and lurid aspects peculiar to the tropics at certain seasons. On the human frame this wind produces a feeling of lassitude and oppression, and a sense of sultriness, similar to the sirocco of the Mediterranean, that cannot be accounted for by the mere difference of temperature. The inhabitants of Mauritius and Bourbon can foretell the approach of a "Malgash wind" by their sensations alone. On the other hand, when the S.E. trade replaces the monsoon, the bracing and exhilarating influence on the physical and even mental energies is very remarkable. When the atmosphere is highly charged with humidity, it is in a great degree rendered unfit to absorb and carry off the exhalations from the skin and surface of the lungs, so necessary to health everywhere, but more particularly so in hot countries, where these are also the means of removing superabundant caloric from the body. Hence the effects of the hot and moist N.W. wind, as contrasted with those of the trade on the animal feelings. We cannot help suspecting that much more is attributable to humidity of the atmosphere in producing disease within the tropics, than to the untangible and obscure poison denominated malaria.

It is thus seen that during the season when hurricanes take place, and over the tract of ocean which they frequent, there constantly exist two masses of atmosphere in motion from opposite directions towards each other; and differing widely in temperature, humidity, specific gravity, and electricity. In a permanently-elastic fluid like air, there is a constant tendency to adjustment existing, by which two dissimilar masses of this element rush towards each other, and commingle with a force and rapidity coincident to their vicinity, and the degree of inequality of the heat and vapour which they contain. On one side there is a comparatively dry and dense stratum of atmosphere, impelled in a fixed direction by steady laws, merely subject to temporary loss of strength, opposed, on the same level, by another stratum, which, although specifically lighter, higher in temperature, and very much more humid, is capable, by its superior elastic force, of counterpoising the former as long as it continues to receive fresh increments of heat from a vertical sun.

Hence, during the presence of the sun in the southern hemisphere, a constant struggle between the two opposite currents of atmosphere may naturally be expected to take place along the interval which separates them. Not only theory, but observation establishes this fact. On the borders of the two winds, ships meet unsettled weather, and variable winds,—at one moment are in a calm, and the next, perhaps, laid on their beam-ends by a squall. It is in this situation that thunder-storms and whirlwinds abound. (See Diagram 1.) To this tract we wish to direct attention, as being not only the locality where rotatory storms are first formed, but along which they move during the greater part of their course, till they acquire an intestine and specific action, involving the neighbouring currents of the atmosphere, which enable them to advance through the trade wind to its opposite limits.

Two currents of atmosphere in motion from opposite points, on approaching the neutral columns of air which intervene between them, cannot be supposed to lose their momentum, or to have their velocity suddenly arrested, or even materially diminished; on the contrary, we must suppose that their motion will be diverted into a new channel. From a knowledge of the forces which propel the currents towards one another, we are prepared to expect that the S.E. trade will have a constant tendency, in a greater or less degree, according to accidental circumstances, to deflect towards the equator, and blow across the line of "variables" into the region of the monsoon. This deviation will be favoured by any temporary diminution of the antagonist force of the opposite current. Suppose, for instance, a sudden elevation of temperature, and consequent vertical current at some part of the monsoon, a considerable barometrical depression must follow, and a rush of the surrounding atmosphere would take place towards the point of diminished pressure, but with greatest force from that side where the heavier and cool S.E. trade-wind was pressing onwards at the earth's surface. This last current, on entering the hotter locality of the monsoon, would quickly acquire its temperature and relative degree of moisture, and consequently its direction. A portion of the trade-wind, in undergoing this change, would curve from its natural course S.E. to south, till it mixed with the monsoon, and then become a S.W., west, and N.W. wind.

Now, the new and periodical agencies which communicate a N.W. direction to the monsoon, evidently cause it to blow from the equator, so that at the point where it meets the trade-wind its course would be north, and from its greater degree of rarefaction would ascend and pass over it. But, in doing so, a portion of it must gradually mix with the colder S.E. wind, lose some of its heat, and partake of the character and assume the direction of the latter, in the course of which it would be found veering from N.W. to north and N.E.

Thus, by the natural deflection of the two winds in opposite directions, a constant tendency would exist in the atmosphere interposing between them to assume a circular motion. The curve of the trade wind from east by S.E., to S. and S.W., to unite with the monsoon, amounts at least to half a circle, while the inclination of the latter from the equator, or in a reverse direction to the former, and to an equal extent, would form the opposite half of a completely connected circle. Even in a liquid there is a constant disposition at the junction of two opposite currents to assume a revolving action, from the simple momentum which they carry along with them. So far the same principle is equally applicable to two moving masses of air; but in the latter case the circumstances are materially affected by a difference of temperature in the reverse currents, at all times a very powerful cause of motion in air, and, in particular, by diverting it from a straight to a curvilinear direction. By this means it seems to be probable that an extensive body of our atmosphere may frequently be involved in a rotatory motion, embracing the borders of the two opposite currents within the sphere of its action, and having the calm or "variable" space in the centre.

It must be acknowledged, however, that it is much more easy to show that this actually takes place, under the circumstances to which reference has been made, than to explain the *modus operandi* by which it is brought about. The existence of the two winds during the hurricane season is a matter long ago ascertained to be regulated by fixed laws. In the preceding cases of storms, it is found that they were of a rotatory kind, and in their first stages, lying between the S.E. trade and monsoon, and afterwards travelling for a considerable part of their course in the same situation. In diagram No. 1, a portion of the tract, and contiguous boundary of the two winds, is laid down in a situation where local causes of disturbance may naturally be expected to happen, and fully capable of producing such alteration in their direction as that their motion may be converted into rotation. It is also seen that all the

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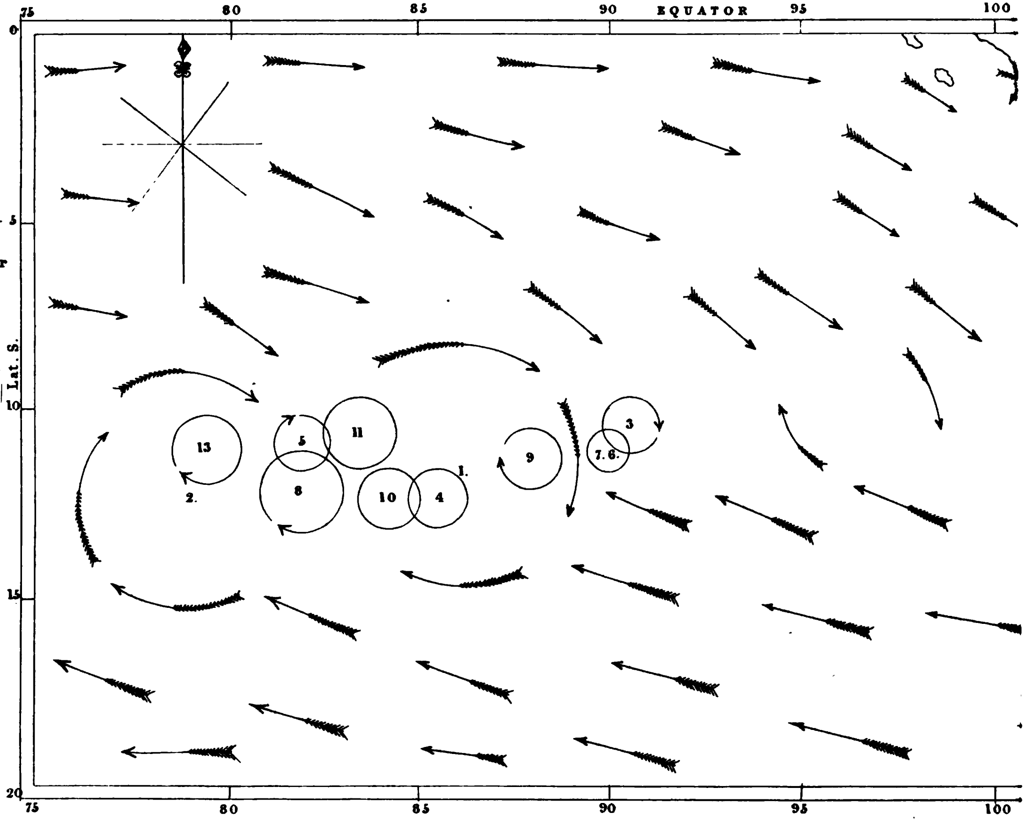
A DIAGRAM SHEWING THE LIMITS OF THE WESTERLY MONSOON & S.E. TRADE WIND WHEN THE FORMER IS AT ITS HE
HURRICANES WHEN FIRST EXPERIENCED.



References to particular Storms

1	Rodriguez Storm	27th Mar
2	Dº .. Dº	29 ..
3	Albions Dº	1808
4	Ganges's	1836
5	Carnatic's	1838
6	E of Hardwicke's	1840
7	Windsor's	1841
8	Seringapatam's	1842
9	Prince of Wales	1844
10	Vernon's	1843
11	Madagascar's	1843
12	Artemise's	1843
13	Exmouth's	1840
14	Fairlie's	1844

storms which have been traced to their origin, were first encountered in a particular locality, perhaps with much less difference in their relative positions than are now given, and from lat. 10° to 12° S., may be considered to embrace their early vortices. It is universally allowed that no hurricane of any extent or duration has ever been found nearer to the equator than 10° S. By this it is meant to say that their centre is no nigher, for in fully developed hurricanes the dimensions of the circle of wind are such as to impinge in a considerable degree on the confines of the opposite currents. Hence vessels may meet with a strong gale several degrees nearer the equator than the position of the vortex.

In every case where a circular storm is clearly determined, a branch of the S.E. trade is found to cross the line of "variables" and enter the monsoon, while the latter recrosses into the former, each gradually deflecting till it appears to be part of the other, and both revolve around a common centre. It has likewise been shown that the disc of atmosphere in a state of rotation is progressive, and, at places over which the centre passes, its first approach is detected by the increasing violence of the S.E. trade, and its departure by a N.W. wind; so that throughout the whole progress of the storm the relative positions of the two winds are preserved. Even the peculiar characteristics of each, as already described, are easily recognised at that part of the circle to which they belong. There is another circumstance worthy of notice in reference to the mutual action of the two currents when involved in a circular motion, which is, that during the early stages the N.W. predominates over the S.E., but, as the hurricane moves towards the tropics, it is exactly the reverse. In lat. 20° and 22° S., the S.E. trade often prevails with tempestuous violence for several days before the vortex arrives; but when the N.W. or west part of the storm sets in, although it blows with equal severity for ten or twelve hours, it seldom continues much longer.

A great variety of causes of a local or accidental nature might be adduced, which, separately or conjointly, may be supposed to act in such a manner as to direct the momentum which two opposing atmospheric currents carry with them into a circular motion. It is not, however, to the smaller masses of atmosphere in stormy gyration that we refer, at least for the present, but to those vast revolving discs which in their early stages are so extensive, as sometimes to include within their central space a number of lesser vortices. The succession of storms, as in 1843, which seem to have had their origin in a particular locality, and rapidly followed one another along a common path, would indicate that whatever the agency may have been that sent them whirling along, it was by no means wholly accidental, but would rather lead us to suspect that its existence is of a permanent kind during a certain period of the year. All the hurricanes which have been encountered near Mauritius and Rodriguez have come from the N.E., and although few of them have been traced to their source, enough seems to have been adduced in the preceding pages to prove that they commence at the limits of the trade wind and monsoon near the Indian Archipelago, more particularly in the neighbourhood of the islands of Sumatra and Java. Farther east, about the island of Timor, there seems to be another locality often visited by rotatory storms. Possibly the whole chain of islands to the eastward of Sumatra, and lying in the tract of the westerly monsoon, may be equally so; but this must be left to future inquiry.

The large island of Sumatra, with its southern extremity stretching across the equator into the tract of the monsoon, as far as lat. 6° S., must necessarily generate new and local currents of air, at variance with and liable to create a derangement in those of a more general nature. Near it, the monsoons, as the S.E. and N.W. winds are there called, blow alternately for six months. However, we are told that, besides these, "there is a daily variation in the winds, which blow every day from the sea to the land during so many hours of each day, and during the night in the opposite direction, from the land to the sea, except only when the monsoon rages with extreme violence, and even (says Marsden) at such times the wind rarely fails to incline a few points in compliance with the subordinate cause, which has not power, in these circumstances, to produce an entire change."* The direct effect of this will be, that the westerly monsoon would be drawn towards the S.W. shores of the heated land, with increased velocity, and in all probability be attended by a fall of the barometer for some degrees to the westward of the island. Towards this part of the monsoon the S.E. trade would naturally rush, aided by its inherent tendency to approach the equator, and veer from S.E. to S. and S.W. till it mixes with the former, and partakes of its qualities and motion; and this may explain the heavy rains which prevail on the west coast of the island, when the wind blows from the last direction, during the prevalence of the westerly monsoon. At night, however, when the cooled surface of the island gives rise to a wind from the land, in opposition to the monsoon, the latter will be resisted in approaching the shore, and turned into a N.W. and N.N.W. direction, parallel to the coast, till it further meets the wind at north, blowing through the straits of Sunda, and off the island of Java, when its course will be north or N.E. towards the trade-wind. By this deflection of the wind taking place a circular action may frequently be established, and other causes with which we are unacquainted may co-operate to make it more complete. It is known that the N.E. monsoon of the China seas, on crossing the equator, in the vicinity of this island, has its course changed to N.N.W., and often blows through the straits of Sunda as a N.E. wind. Supposing the existence of this latter wind while ten degrees farther west, the S.E. was blowing across to the monsoon, the four sides of a circle would be perfect. About the time when the Rodriguez storm of 1843 was forming in this neighbourhood, the *Katharine Stewart Forbes*, in passing through the straits of Sunda, and off the west end of Java, had a N.E. wind, while, in long. 80° and 82° E., other vessels had a south and S.W. wind between the monsoon and trade.

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* Encyclopædia Britannica—article, *Sumatra.*

The effect of local currents generated by heated land, may be supposed to act somewhat in a similar manner in the vicinity of all the islands to the eastward of Java; and near the N.W. coast of New Holland we are prepared to expect very extensive disturbance in the two great winds, so often alluded to. During the hurricane season of 1843, it is said that "violent N.W. winds had prevailed in the Molucca seas," during January and February. At the north end of New Holland,* the westerly monsoon would first blow N.W., then north, direct to its heated coast, and the S.E. trade to the westward is known to veer to south and S.W., thus forming two segments of a circle, so situated as readily to be completed by the ordinary winds, at east on one side, and west on the other. It is also possible that the Chagos Archipelago to the westward of Sumatra, may sometimes be concerned, on the same principle, in giving rise to hurricanes; but, at Seychelles, still farther to the westward, storms are absolutely unknown. Both these groups of islands lie in the tract of the westerly monsoon. A vessel, belonging to Mauritius, was lying at the former place during the Rodriguez storm, and had no bad weather. Near the N.E. extremity of Madagascar, however, the state of the atmospheric currents appears to favour the formation of rotatory gales, and in that neighbourhood, southerly and S.W. winds frequently prevail in the hot months of the year.

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* See Appendix for some additional account of the storms of the west coast of New Holland, received since the preceding pages were in the press.

It is to be understood, however, that the effects of local currents of air are only to be considered as subordinate or exciting agencies in the formation of hurricanes on a vast scale, and their influence is neither necessary to support the stormy revolution of the atmosphere, nor urge it onward in its distant course. It is even possible that unequal pressure depending on accidental causes, unconnected with land, at any part of the monsoon, by facilitating an irregular advance of the trade-wind at one or more points, might end in a revolving motion of the two. This state of things may naturally enough be contemplated when the solar influence begins to decline, and with it the force which gives birth to the monsoon, and sustains it during its temporary sway. Still, although this may be conjectured, we find that in the South Indian Ocean storms are much more frequently called into existence by the neighbourhood of land.

Whether the opinions which have been advanced regarding the formation of rotatory gales approach the truth, must in some measure depend on future observation; one point, however, seems to be satisfactorily ascertained, that they are generally developed in the interval between, what we may be allowed to call, their parent winds, and in intimate relation with both, in such a manner that each would convey additional impulse to the revolving mass at the opposite sides of the circle. In this manner a storm may be supposed to receive accessions of impetus at the exterior of the circle, by the conversion of the rectilinear force into a circular motion, and by enlarging the sphere of its action it would impinge more extensively on neighbouring winds, and receive a continuous support. Even if the contiguity of two winds is not required to form a rotatory motion in the atmosphere, it appears to be absolutely necessary for the continued existence of such an action. There seems to be no other cause adequate to explain the duration of hurricanes for fifteen or twenty days, while travelling along a distance of 3000 miles: and finding that they arise between regular but opposite currents, continue their progression in the same relative position, and only terminate or lose their specific action at that point where the two winds cease to be regular, or near the extra-tropical "variables," it is consonant to reason to trace a connexion of cause and effect between them.

Although water is not affected by temperature in the same degree as a permanently-elastic fluid, its currents may without impropriety be employed, by way of analogy, in exemplifying this part of the subject. Every one must remember to have observed, that in a body of this fluid where two currents enter near one another, and more or less at right angles, there is a constant tendency to form eddies or circles. Even where an impediment, caused by a rock, occurs, and a stream is divided, at the angle where it again meets behind the cause of obstruction, the same circular motion is liable to be formed, and small whirling portions of water, with concavities near the surface, are seen successively drifting down the common stream. In some cases, when two streams enter at opposite sides of the body of water, the whole is set in motion and a vast whirlpool is established. But an easy mode of ascertaining this at once presents itself by directing two currents to enter a body of still water at different angles, when it will soon be discovered that a circular motion is quickly formed, and continues as long as fresh momentum is supplied. The velocity and extent of the rotation of course depends on the strength and body of the two currents from which it derives impetus. The same force is also capable of being made to produce a very perfect degree of gyratory motion, on an axis inclining from the perpendicular, according to the direction and level by which the streams are made to approach each other, proving, what might be expected, that certain angles are more favourable than others to produce vortical action.

The same principle is evidently the cause of those turbulent and eddy-like motions of the atmosphere, wherever its currents meet in opposition. To the leeward of capes and lofty mountains, which break the wind and turn it into channels at variance with each other, it is common to experience squalls and whirlwinds, with the wind in every direction. The gale that blows straight across the plain, on striking against the buildings of a town, assumes almost every direction of the compass in different streets, and every one is familiar with certain corners where the currents of air meet and keep up an almost incessant eddy or succession of eddies. The small bodies of air thus set in revolution are seen to have an axis varying in all the angles from vertical to horizontal, and exhibit the effects of centrifugal action on an elastic fluid, by the formation of an up-current at their focus, capable of raising solid bodies from the earth. If, therefore, irregular, uncertain, and temporary currents of air under certain circumstances have a tendency to assume a circular motion, is it not still more likely that vast and equable currents, if exposed to similar disturbances, would be affected in an analogous way. The laws which govern an eddy are equally applicable to a larger whirlwind, a tornado, or hurricane. The force which is in operation is only a modification of the laws of gravity, and those laws equally influence the motion of a grain of sand or a huge rock, a particle of air or a cannon-ball.

But in the further examination of the ordinary phenomena which are disclosed during a hurricane, we may find additional facts tending to substantiate the opinions which have been hazarded regarding the atmospheric conditions which terminate in the formation of circular storms.

In the Rodriguez hurricane every ship approaching it from the eastward brought *easterly* winds with her and on the opposite side *westerly* were experienced far beyond the extreme limits of the hurricane.

In fact the track of this storm, as laid down on the chart, may be considered as the boundary of the two winds during the stormy season of 1843, and it has been shown that a succession, almost unceasing, of other revolving gales were travelling along the same path. By reference to the chart it will be seen, that not only the central path of this but of almost every other storm is seen to be nearly confined to the tract of "variables" which lies between the trade-wind and monsoon. And as it is well known that the S.E. trade, during the hot or hurricane months, is much farther from the equator on the African coast, and, in fact, rarely extends to the westward of the Islands of Rodriguez and Mauritius, except for a few days at a time, its N.W. and westerly confines may almost be traced by the curves of storms moving round it. And these, of course, vary a little in position, according to the relative force of this and the antagonist wind. It is almost unnecessary to remark, that the fact of the trade-wind being periodically subject to such limits, is conclusive with regard to the co-existence of opposing currents and forces in direct proximity.

SECTION VI.

THE PHENOMENA DEVELOPED DURING HURRICANES IN THE SOUTH INDIAN OCEAN.

CONTINUOUS CAUSES, PROGRESSION, CENTRIFUGAL ACTION, FOCUS, DIMINISHED PRESSURE, CONDENSATON OF VAPOUR, TEMPERATURE, ELECTRICITY, PERIODICAL ABATEMENTS OF VIOLENCE, INFLUENCE OF LAND, ETC.

IN the preceding sections the chief aim has been to show that hurricanes in the Indian ocean, south of the equator, are vast circuits of wind, revolving in a particular direction, with unerring regularity; that they move from about lat. 10° S., by a south-westerly track, curving towards the tropic, and that their diurnal rate of progression diminishes as they recede from the equator. An attempt has also been made to discover the locality of their first development, and from their apparent connexion with two adverse currents some remarks have been offered on the probable circumstances which give rise to a circular motion of so vast an extent of atmosphere, and continue to supply the fresh momentum requisite to prolong its duration. Of the rotatory nature of these tempests there seems to be scarcely a doubt, and those who may not be satisfied with the facts which have been adduced on this point, are referred to the valuable works of Redfield, Reid, and others.

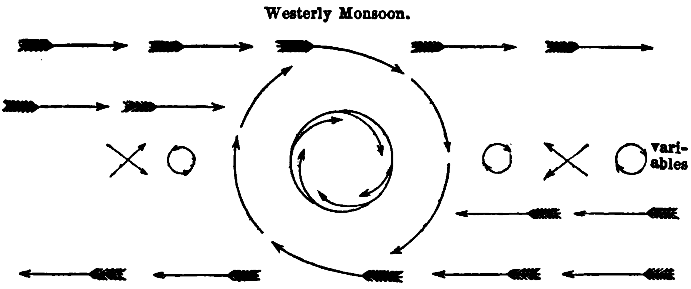
Some attention may now be devoted to the consideration of the series of phenomena which are developed subsequently to the formation of the vortical motion, and are apparently the consequences of this peculiar action on a permanently-elastic fluid like air, and its various constituents. By this means an indirect but recognised method is obtained, of approaching to a more perfect knowledge of the first causes. Many of the phenomena disclosed during a hurricane strike our observation so much more forcibly than others, or the whole taken together, that they are often considered to be causes, instead of effects, and perhaps, from the veil which still hangs over the subject of storms, this is an error not easily avoided.

Although a whirling mass of atmosphere will acquire an intestine action from the rarefaction of air at the centre, it must receive a steady accession of force at the exterior in order to endure for any length of time. It is possible that the vast extent of air involved in a rotatory storm may retain its motion for some time after the *primum mobile* has ceased, but certainly not for two or three weeks, and while it travels over thousands of miles.

When hurricanes are first discovered, their diameter is from 400 to 500 or even 600 miles, and, as the interval between the monsoon and trade wind seldom exceeds 100 or 120 miles, it follows that the sides of the circle must involve the limits of the two winds for the space of 200 miles on both sides. There is, therefore, nothing unreasonable in supposing that each wind would communicate a part, if not the whole, of its momentum in a tangental direction to the periphery of the revolving mass interposing between them, and by their reverse motion produce a unity of action, well adapted to sustain the storm, in the manner which the following diagram (No. 13) represents.

If the S.E. trade impinges on one side at the rate of 30 miles per hour, and the monsoon at the same velocity on the other, the amount of force converted into a rotating motion would be equal to 60 miles at the exterior.

DIAGRAM 13.



It is by no means easy to conjecture, with any degree of accuracy, to what height in the atmosphere the stormy revolution extends. As both the upper and lower currents are engaged, and apparently necessary to its continuance, there is every reason to suppose that a hurricane affects the atmosphere to a very great elevation. Among the Alps, storms of a far more limited extent than those referred to in the tropics, have been seen to pass over mountains 15,000 feet high without touching them; they are even said to have been seen passing above Mont Blanc. It must also be remembered, that in these cases, it is only the base of the storm cloud that is visible. If such is the case in colder regions, it is still more likely to occur within the torrid zone, where the height of the atmosphere is so much greater at all times, and especially during the increase of temperature due to the hurricane season. The fact of revolving gales passing over the lofty mountains of Mauritius and Bourbon, from 3000 to 5000 feet high, without being perceptibly delayed, or affected in any way, is at once a proof that the specific action is extended far above the surface of the earth. Yet both these islands materially arrest the trade-wind, and divert it into new channels.

In the first stage of a circular storm, it is probable that the wind blows round the exterior with greater violence than towards the central space, which would appear to be occupied by air almost in a state of stagnation, or subject to brief and irregular motions. But as the external motion is imparted to the interior portion of the mass, and centrifugal action begins to withdraw the air from the centre, and form an up current, the whole will soon be involved in the same vortical action.

It has been shown that the two adverse winds which enter at opposite sides of the storm are in very different states with regard to heat, vapour, and electricity; it is therefore to be expected that when suddenly intermingled, an extraordinary development of natural forces will be the result. Even two masses of air, subject to an equal degree of dissimilarity, although at perfect rest, if in contiguity would, from the natural tendency to commingle which they possess, be productive of many remarkable meteoric phenomena. In how much greater degree would this result follow when they are violently brought together by means of rotatory action, and its subordinate effects. Perhaps the energetic display of elementary force incident to hurricanes is only indicative of this law of adjustment in activity, by which the unequal distribution of caloric and vapour is corrected; and thus even the stormy commotions of the tropics are natural agencies called into existence by the very circumstances which render them necessary, and only cease when that necessity disappears, and the ordinary equilibrium of the atmosphere is re-established.

The more awful phenomena which are presented to our senses during a hurricane, seem to depend on the reduction of the two temperatures to a common standard, such as the condensation of vapour, manifestation of electric energy, &c. The comparatively cool trade wind, on entering the circle, will be rapidly carried round to the hot and humid monsoon, and there receive increase of temperature, both direct and by the liberation of latent heat from condensing vapour, it will become buoyant, and, in conformity with the laws which belong to the monsoon, instead of tending towards the equator, assume a contrary direction, and join the current to which it has suddenly become assimilated. On the other hand, the N.W. wind, naturally rising to form the upper current towards the pole, in passing over the lower and opposite one, will, to a certain extent, give out a part of its caloric, by which its specific gravity will be augmented, and it will partially sink into the surface wind and add to the revolving motion. This process, however, will be greatly limited by the abundance of latent heat let loose by the precipitation of vapour.

Progression.—The co-operation of two opposite winds, not only maintains a gyratory motion of the atmosphere lying between them, but may also be assigned, with more propriety than any other, as the sole cause of a hurricane's progressive motion in a fixed direction. As the rotation and progression of a storm are almost simultaneously discovered, and seem to terminate together, it may very naturally be inferred that they are the effect of the same agency, perhaps under different modifications. It would be absurd to suppose, that a primary impulse given to a discoid body of air would send it spinning from the coast of Java to the Cape of Good Hope, with a rotatory velocity increasing, to a certain extent, with its forward movement. The primary momentum would be expended by the friction it would encounter from opposing currents and terrestrial impediments, ere it had moved many degrees. Yet some impetus must be found that accompanies the storm from its commencement till it quits the tropics. Why is its course and existence confined to a tract where the trade wind blows on the surface of the ocean, in one direction, and the westerly monsoon, partly on the same level, and partly as an upper-current above it, in another? These are the only regular and counter-currents of atmosphere on our globe, and at the extra-tropical borders of the trade they cease, or at least become variable. Now, the vortical storms which pursue a definite path are limited to this region. There is no authentic case on record, where a storm's centre has been found nearer the equator than the margin of the trade-wind next the monsoon, nor are there, as yet, any satisfactory traces of a rotating action in storms being continued for any length of time beyond the opposite border of the same wind.

The general conditions of the reverse winds are such as to lead to the conclusion, that the lower surface of the storm and its vortex are more decidedly under the influence of the cool and heavy S.E. trade, while the upper stratum is subject to the N.W. or polar current. In fact, the mass of atmosphere in stormy gyration is, in a certain sense, isolated by its peculiar action from the surrounding columns. Hence the trade-wind, at the same time that it strikes against the eastern side of the circle, and communicates rotatory action to it, would incline to carry it to the westward, while the monsoon, or equatorial current (for we consider them as differing only in reference to the levels on which they blow), would urge it from the equator to the pole. The combined, although antagonist, agency of the two would thus end in whirling it to the S.W., varying a point or two perhaps on one side or the other, according to the relative force of the moving powers. By this it will be seen that in reality the remote causes are the rotation of the earth on its axis, and the heated currents of air flowing from the equator, and this may help to explain the fact of the velocity of the progressive motion gradually diminishing as the storm passes out of the tropic.

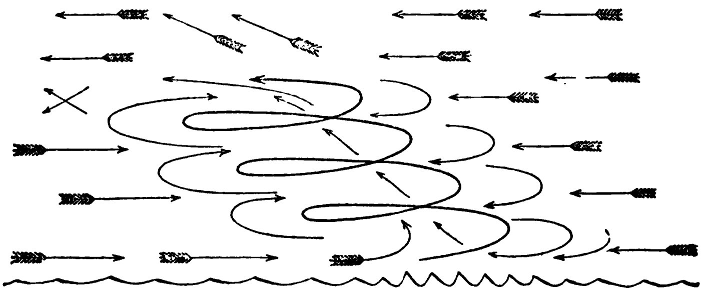
In the case supposed, of the S.E. wind hurrying the lower part of the storm in one direction, while the north-westerly current was pressing the upper half in another, it might be imagined that the struggle would end by separating the two strata involved in the rotation, and dissipating the tempest. But we think that the centrifugal action incidental to vortical motion gives rise to a complex series of phenomena, particularly that of an up-current in the focus, sufficient to retain the whole body of atmosphere within the range of the storm in juxtaposition, and resist the conflicting force of the two adverse currents. Both observation and the theory which has been advanced concur in making the east and S.E. portion of the hurricane on the surface of the earth more extensive and severe than the N.W., or westerly half of the circle, when near the tropics; and, in all probability, this would be found to be reversed in the higher regions. We have already alluded to an opposite relation in the state of the winds, when the storm is found nearest to the equator.

In some instances, if not in all, there is reason to think that the point, or focus, of maximum barometric depression, is at some distance in front of the centre around which the tempest blows on the level of the sea. The particular cases which lead to this inference will presently be considered, more especially that of the Rodriguez storm, on which so much stress has been laid. It is easy to suppose how this might occur, by the upper part of the vortex being impelled forward with more rapidity than the lower and denser portion subject to the influence of the trade wind. It is thus evident that the axis of rotation would incline from the perpendicular towards a horizontal position, in the manner represented by the following diagram, No. 14, and explained by Table E, at page 181.

Whether this is accidental, or a usual character of hurricanes, or exists only near the tropic, may hereafter be ascertained with greater exactitude.

It may also be inferred, that during the formation of a hurricane in the neighbourhood of the Indian Archipelago, its centre is nearly stationary, or begins to progress with unequal and eccentric motion, and it appears as if, Diagram No. 14.

Inclination of the Axis of a Hurricane.



in the first instance, it embraced several small vortices, formed by the gradual effect of the wide exterior circle in withdrawing air from the interior space. When the rotation extends throughout the mass, and the vortex is narrowed to that relation which it must naturally bear to the centrifugal and circular motions, and the whole acquires a reciprocal and combined action, it would then seem to be carried along its legitimate track by regular stages. The Rodriguez, and every other storm which has been brought under our cognizance, when once set agoing, in 12° and 14° S., moved onwards at the rate of 200 or 220 miles in twenty-four hours; but about 20° and 22° S., this was reduced to 100, and beyond 26° S., scarcely exceeded 50 miles.

The whole of our inquiry has tended to the inference that hurricanes terminate as they enter the variables at the outer limit of the trade-wind. It is not impossible, however, that, on leaving the tract of the S.E. trade, the upper-current, after sinking down to form the westerly wind, might, for a time, turn them into a S.E. course, between itself and the contiguous border of the trade-wind. The operation of the two currents in their new relation would be quite conformable to the same mode of rotation, and altered direction of the storm. This would agree with

Colonel Reid's opinion, that the *Culloden* storm turned to the S.E. But we have elsewhere attempted to show that the facts advanced in support of this opinion want the corroboration of other cases.

Arguing from what has already been said, it may be inferred that when a hurricane has left the region of the trade, about lat. 28° or 30° S., it loses its continuous causes of support and progression, and will gradually begin to break up, although its existence may occasionally be prolonged for a brief period, by accidental or temporary currents being favourable to the continuance of its specific action. Circular storms may arise between any two winds, but their duration and progression will be more or less regular, according to the relative force and permanence of the antagonist agencies.

It is possible that the diameters of storms in the Indian Ocean differ from each other in a more important degree than has been allowed, and that the progressive motion will be more rapid and uncertain in those of smaller dimensions, as is supposed to be the case in the opposite hemisphere. The question is one not easily solved in a tract of ocean with so very few fixed points of observation as that under our consideration. However, it has been inquired into; but, so far, there seems to be no very obvious reason for thinking that any of the storms which have been reviewed moved onward with greater velocity than that which has been specified as belonging to certain latitudes. The *Culloden* storm has some appearance of advancing more rapidly than that of Rodriguez, yet in the former, as well as in the latter case, the ships felt it and kept before it many days; and only when both they and the vortex changed their courses did they come in collision. But it is impossible, with our present knowledge, to explain all the minor movements and phases to which a hurricane may be subject. Nor is it quite clear that the vortex may not be liable to slight oscillations from its central path, although no conclusive evidence exists on this head; but as the track is determined, it is most probable that the focus also pursues a steady course along it, at least in storms embracing several hundred miles of atmosphere, and which, compared to the height of the whole mass, are mere flattened discs.

It may be objected that the termination assigned to hurricanes in the Indian Ocean is not in accordance with the effects of similar principles operating in the movement of storms in the northern hemisphere, particularly near the coast of America. The West India hurricanes, in their curvature from the equator, appear to impinge on the North American shore, along which they are directed for some distance, and then, it is said, recurve to the N.E., entering the westerly "variables." In fact, they appear to follow the line of coast which agrees with the inclination of their course. We are not prepared to discuss the question; but may be allowed simply to surmise, that the change in the track of storms, in the North Atlantic, is attributable to the influence of that vast surface of land, not by its physical form, but by the generation of new and extensive currents of atmosphere, at variance with those of a more regular kind. Supposing the higher S.W. current, flowing from the equator towards the poles, gradually to deflect to west and N.W., over the great continent in question, and thus be opposed to the easterly trade-wind, blowing from the ocean to the coast, the hurricane would thus move between the limits of the two, in conformity with the gradual veering of the westerly winds, and be forced more or less to the westward by the relative changes in their position. As the trade-wind reaches farther from the equator in the northern than the southern hemisphere, it may account for the storm in the former being carried more remote from the tropic of Cancer before it breaks up. We merely advance these opinions as being probable, not having made the subject a matter of inquiry.

Effects of centrifugal action.—A mass of air resting on the surface of the earth, being involved in circular motion, and constantly receiving fresh momentum at the exterior, will speedily become endowed with that centrifugul action common to all bodies similarly situated. But, from the low specific gravity of the atmosphere, the mobility and elasticity of its particles, and its density rapidly decreasing from below upwards, this new agency will be attended by effects of a much more complicated nature than would occur in solid or even fluid substances. To what altitude the circular and centrifugal forces extend, we have no means of ascertaining, but it is probable that they are in just relation to the specific gravity of the air at different heights. Their united operation would enable the revolving body of air to resist the lateral pressure of the surrounding columns, and by isolating the focus produce that diminished weight of the atmosphere towards the centre which is indicated by the barometer.

The effects of centrifugal action on a solid, revolving on a fixed or even moveable axis, afford no analogy for elucidating this part of the subject. Even the circular motion of a liquid is very inadequate to a full and satisfactory explanation of all the phenomena incidental to a mass of atmosphere in rotation. In a limited degree it is applicable, as, in the case of water, we perceive that the centrifugal force produces a concavity at the surface coequal to the degree of rotation at the exterior, and to a certain extent there is an ascending current near the centre; but as this current is of the same density with the surrounding mass, its vertical motion is proportionably retarded. In a permanently-elastic fluid the case is different, for as the pressure is removed, the air increases in bulk, diminishes in specific gravity, and its upward tendency follows as a matter of course, and will take place with a velocity equal to the newly established disparity between the ordinary weight of the atmosphere at the periphery and that of the focus.

In a body so constituted as the atmosphere, centrifugal force will also be followed by very different consequences at the opposite surfaces of the revolving disc. At the upper part, where there is less friction, and the lateral resistance is decreased, the atmosphere will be thrown off to the exterior, and a removal of the incumbent pressure take place, greater near the focus, and lessening towards the margin. A rush of air from below towards this point will be induced, and be in proportion to, and contemporaneous with, the agency creating it. The loss of equilibrium between the centre and external parts of the circle must increase downwards, and be greatest at the base, where the heavy stratum of air in contact with the surface of the earth will be drawn towards the vortex, or point of minimum pressure, and in turn it will assume a vortical direction, by forming the focal current. The velocity with which the lower currents will hurry towards the vortex must of course be in proportion to the extent of barometric depression. The circular motion first acquired at the exterior will be gradually increased as the air enters within the sphere of the vortical action, and of course must become more gyratory and violent the nearer it approaches to the edge of the space where the up-currents begin. This is in accordance with the laws of motion, by which fluids, when obstructed by friction, rush towards a syphon, or flow through a narrow opening.

In fact, it is by this effect of centrifugal action peculiar to air, in decreasing its weight at the centre, and generating a focal current, that we are able to account for the augmented violence of the hurricane towards the vortex, while the increments of motion are applied at the margin. When a solid body is in a state of rotation, the motion decreases from the exterior towards the centre, as the square of the distance, but there is no parallel between the cases; and in liquids, although there is mobility of their particles, the density never changes at any part of the circle, and the great distinction between them and air, that of an up-current in the focus, remains unchanged.

Therefore, in a revolving body of atmosphere, in addition to, and as a consequence of the circular and centrifugal forces, there is an in-draught of air at the lower or denser part, which rushes up through the focus and is ejected at the upper surface. The centrifugal action, by resisting the lateral pressure of the atmosphere, forms a cylinder, up which the law of gravity forces the air to enter at the extremity resting on the surface of the earth. The velocity with which this is effected may be estimated by the degree of barometrical depression.

In most of the hurricanes the fall of the mercurial column near the centre is at least one inch, in many cases, however, the amount is nearly equal to two. Hence, as in the former case, the atmosphere at the level of the earth will be impelled towards the vortex by a force equal to half a pound on the square inch, or rather more than the weigh of a column of water a foot high pressing on the same surface. Now Dr. Young says, that "the pressure of a column of water one foot in height would force the air through a small orifice with a velocity of 230 feet in a second, corresponding to the height of 830 feet of air (of equal density throughout); a column of mercury one inch high would produce the same effect as a reservoir of water more than thirteen times as high; and the force of the air confined in a closed bottle under the receiver of the air-pump will cause a jet to rise to the same height as a column of mercury, which measures the difference of the elasticities of the air in the bottle and in the receiver." *

The result would give the velocity of the wind, just as it enters the focus, at the enormous rate of 156 miles per hour. Something must be subtracted on account of the friction caused by the surface of the earth; but even admitting this to be nearly equivalent to one-third of the

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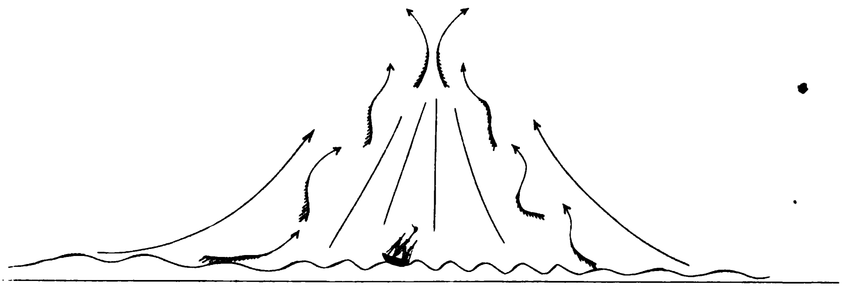
* Young's Natural Philosophy, vol. i. p. 279.

whole, it still leaves a tremendous force. It is to be observed that this force only exists near the vortex, and that it diminishes towards the circumference. Experience has long confirmed the fact of the hurricane's violence being most terrific at the edge of the calm which constitutes the centre. The strength of the wind at this point of the storm has, we suspect, never been exactly measured, and rather under than over estimated ; but the details of damage done to solid buildings,—the enormous bodies raised in the air,—trees torn from the earth, and the masts of vessels, secured by powerful stays, snapt like fragile reeds—are ample evidences of an overwhelming force being imparted to it.

The Focus.—The centre of a rotatory storm may be described as that space where the horizontal direction of the wind suddenly ceases, and often, in half an hour after the tempest has unfolded its most terrific powers, a perfect calm supervenes, and lasts from four to six hours at the places over which it passes, when the hurricane recommences, with all its pristine violence, from a point of the compass nearly opposite to that where it left off. This appears to be a phenomenon essentially characteristic of all tropical hurricanes, and is always remarked where the centre is experienced. So great is the change of weather in this situation, that, but for the barometer continuing nearly at its lowest range, a person unacquainted with gales of this nature would conceive that the whole was over.

This strange and abrupt cessation of a tempest is well known to every inhabitant of Mauritius as its invariable concomitant, and too often as the harbinger of fresh disaster. Its duration depends on the rate of progression, and extent of the calm circle passing. When the edge only is felt, we find that "sudden lulls and gusts" distinguish it; but the central space is a "dead calm." In the Rodriguez storm, vessels were repeatedly in and about this spot. In that of 1840, its duration and extent are

DIAGRAM Nº XV.



The calm & up-current at the centre of the Storm

DIAGRAM Nº XVII.

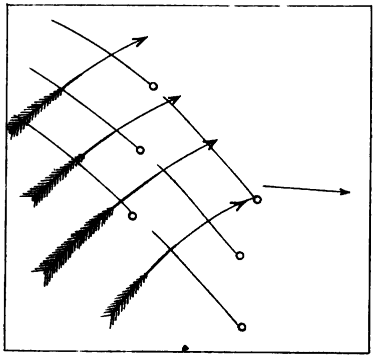
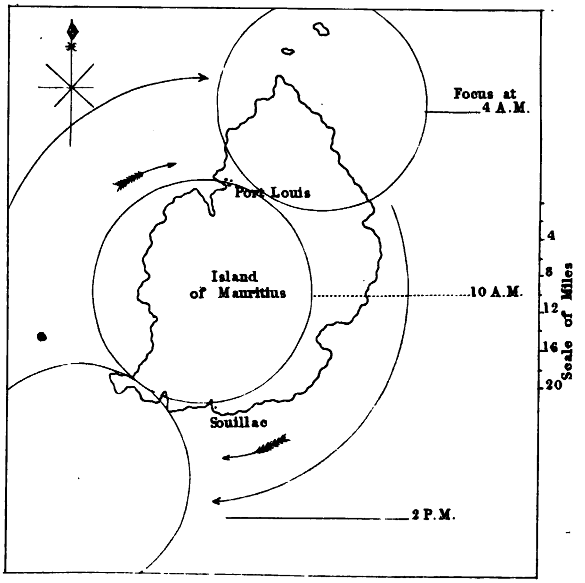


DIAGRAM Nº XVI.



The movements of the centre of the Mauritius Hurricane of April 1840 when over the Island.

given in Table A and Diagram 16. In the *Albion* storm, all the vessels experienced a lull for an hour or two; in that of 1836, when passing over Port Louis, the calm was from three to four hours; in the *Neptune* storm it lasted six hours; in the *Carnatic* gale four hours; with the *Windsor*, in 1841, its duration was eight hours; in the *Exmouth* storm one hour; and in other instances for a less space of time. In the West Indies the same fact appears to have been observed, although allegations have been made against it.*

In another place we have attempted to measure the extent of the focus by the time it took to move over a distance of 21 miles. The calm commencing at Port Louis four hours before it reached Souillac, at the opposite end of the distance, and its appearance at the last place being almost simultaneous with its cessation at the former, it is inferred that its diameter was nearly equal to this distance, and its progression about five miles per hour.—See Diagram 16 (Plate VII.), and Mauritius hurricane of 1840.†

From what has already been advanced, it will be seen that facts, as well as hypotheses, indicate the calm in the centre of a rotatory gale to be very much more extensive at the beginning; and that the circle, when first formed, embraces an extensive area of atmosphere belonging to, and in the same condition as, the variables. In the *Artemise* hurricane there seems to have been something of this kind; and in the *Windsor* storm the calm lasted for eight hours, but surrounded by a violent tempest. Supposing this storm to have moved at 10 miles per hour, the usual rate in the latitude where it was encountered, it would give the diameter of 80 miles. It is clear that it was moving fast, as it quickly left the *Windsor* when hove-to, and afterward she could not overtake it at nine miles an hour. On the 1st of April, in the Rodriguez storm, the *Blanche* and *Broxbournbury*, 30 to

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* The same circumstance was noticed in a hurricane at Shark's Bay on the north-west coast of New Holland. See Appendix.

† Also refer to Note 2 in the Appendix.

40 miles apart, were on opposite sides of the storm's centre, and had weather such as occurs at the edge of the calm. It seems to have been further reduced in speed ere it reached 22° S., and was certainly less than 20 miles in extent.

When the atmosphere ceases to brush along the surface of the earth, and meets resisting objects by which its motion becomes perceptible to our senses, we call it a calm, but this is no proof of quiescence. That such should exist near the centre of the storm and diminished pressure, is in accordance with every view which has yet been offered. It cannot be supposed that the atmosphere, approaching in rapid gyrations towards the base of the focal current, would continue its horizontal motion straight to the centre, and abruptly begin to ascend, at a right angle: in fact, it is almost physically impossible, and opposed to the dynamic laws of elastic fluids. On the contrary, it is consonant to reason to believe, that, as the air rushes with velocity towards the locality of least pressure, it will begin gradually to assume the vortical direction, at some distance from the very centre, as represented by the Diagram No. 15 (Plate VII.). A triangular body of atmosphere at comparative rest would thus be established. At the edge of the calm, where the ascending motion takes place, the air would seem to rush upward, in a sudden and irregular manner, with a spiral motion, or in a number of smaller vortices. By this we may explain those terrific gusts and intermissions of the gale which usher in the calm and succeeding half of the storm.

Admitting the diameter of the focus of a hurricane to be 20 miles, and its area containing about 300 square miles, it will allow a current of air to escape, equal to a stratum of the trade-wind, five degrees in width and one mile in height; the velocity of both being equal. This may in some measure account for the extent of trade-wind from the eastward entering the vortical circuit, and without any obvious outlet at the level of the earth.

The height to which the focal current reaches would appear to be at least equal to, if not greater than, that of the stormy zone by which it is engirt. By the rapid ascent of the air, and convection of heat, the temperature of this isolated column of air is kept in the natural adjustment from below upwards proper to its condition at the base. Hence that appearance of improved weather peculiar to the focus. In the tremendous hurricane of the *Exmouth,* when the mercury was below the level of the scale, the wind was suddenly hushed, and the *sun broke forth.* In the Mauritius storm of 1840, during the calm, blue sky was seen, and the sun occasionally became visible for a few minutes at a time, while the tempest was raging at 10 miles distance on every side.

There is no difficulty in tracing out distinct proofs of the existence of a central space in the Rodriguez storm of 1843, where the tempestuous force of the wind ceased to be perceptible, but the infuriated state of the sea was unabated. On the 1st April the *Broxbournbury* and *Blanche* had it so moderate as to let out all reefs, while the *Robin Gray* was under close-reefed top-sails, and the *Velore* and *Framjee Cowajee* were scudding under three-reefed top-sails. On the 3rd the *Argo,* while under bare poles, found the storm suddenly moderate at 2 P. M., and she set her top-sails, but at 6 P. M. was obliged to stow them, "with every appearance of a hurricane." On the 6th, the *Robin Gray* states in her log, "that it lulled a little for a short time; the sky looked rather finer, when presently it assumed a wilder aspect than ever, and blew a hurricane." On the 7th, from 4 to 8 P. M., the *Waverley* and *Sea Queen* had a similar cessation of the storm.

That air ascends in a focal current, seems to be beyond a doubt. But it is a matter of mere conjecture what takes place at the higher part of the focus, or whether the upper parts of the atmosphere do not pour down a counter-current, and meeting that from below, both are thrown off by centrifugal action, at a level some where between the superior and lower currents. But it is equally possible that a strong revolution, over a diameter of 300 to 600 miles of the lower and denser part of the atmosphere, lasting for fifteen or twenty days, would extend its action to the very highest regions. From the small quantity of vapour existing in the higher strata of the atmosphere, there is no means of observing their commotion. During hurricanes, however, the heavens are completely veiled from view, except occasionally over the focus. If air falls into the latter, the latent heat set free by its descent, would increase its temperature, and prevent the extensive formation of clouds within its range.

There is something unnatural and portentous in this sudden cessation of the storm, and the existence of a circumscribed space of tranquil atmosphere, bounded by well-defined banks of dark clouds, beyond which, for many hundred miles on every side, there is one continuous bed of vapour borne along with unabated fury. On land, ruined buildings, branchless trees, and rivers inundating the country, meet the eye. But what is this to the dismasted vessel, half filled with water, and almost sinking under the enormous sea continually bursting over her? To her exhausted crew, this fearful calm, increasing turbulence of the ocean, and the prognostications of a low barometer, are even more terrible than the tempest again about to pour out its fury on their ill-fated craft.

The state of the Barometer.—The result of extensive observation shows, that under ordinary circumstances, the atmosphere within the tropics is not subject to the same sudden and local disturbance of its pressure as in the temperate zones. The existence and regularity of the two great counter-currents seem to provide against the frequency of those causes elsewhere leading to great and temporary depression of the mercurial column,—the loss of equilibrium in one stratum being immediately compensated by the other. Hence it may be assumed that whenever any extraordinary degree of barometrical change takes place, it is in consequence of a cause affecting both the currents. But, in common with every other region of the earth, the atmospheric pressure is liable to be influenced by the calorific action of the sun during the summer months; and at Mauritius, the mean annual variation is about ·375, or rather more than one-third of an inch. By reference to the Tables B and C, (p. 142) it will be seen that during the month of July the barometer stands at 30·150; it begins to fall in almost equal monthly gradations till December, when it is down to 29·80, or lowest mean annual range, and in the course of the next six months ascends in the same regular manner. The diurnal oscillations nearly follow in the same way as in other tropical countries. The most important alterations, of a temporary kind, which take place at Mauritius, arise during the transition of temperature incident to a change from the S.E. trade to the monsoon, as shown by the following extract from a meteorological register, which affords a tolerable idea of the state of the weather at the borders of these two great surface winds on ordinary occasions when undisturbed by tempests.

Variations in the pressure of the atmosphere to the extent exhibited by the annexed table are common enough, but rarely or ever exceed ·25 or ·30; but this, in connexion with the meteoric condition of the two opposite currents, implies the frequent existence of two very dissimilar bodies of the atmosphere in proximity to one another, and ready to add their force to a rotatory mass moving between them.

Now this very tendency of the atmosphere to preserve a comparatively uniform pressure in the tropics, where uninfluenced by land, renders the barometer an instrument of inestimable value to the mariner when traversing these regions during the hurricane seasons, — for this reason, that no unusual fall of the mercurial column ever

TABLE D.

EXTRACTS from a METEOROLOGICAL REGISTER kept at PORT LOUIS.

Date.	Barometer.		Thermometer.		Dew Point.		Wind.	Remarks.
	9 A.M.	3 P.M.	9 A.M.	3 P.M.	9 A.M.	3 P.M.		
1842								
Dec. 17th	29·98	29·96	80°	82°	74	76	N.E.	Hazy, oppressive, light showers, almost calm.
„ 18th	29·94	29·88	80	83	75	76	North.	Do., do., lightning.
„ 19th	29·88	29·86	82	80	75	77	Variable.	A heavy shower. Much rain fell at Plein Wilheims, 800 feet above the level of the sea.
„ 20th	29·86	29·84	82	86	76	76	Do.	
„ 21st	29·83	29·82	82	80	74	76	N.	Close oppressive. N.W. current of clouds.
„ 22d	29·76	29·74	82	83	74	76	N.W.	
„ 23rd	29·76	29·74	79	81	74	76	N.W.	Rain, lightning, and thunder. The thermometer 74° at night, during heavy rain.
„ 24th	29·70	29·68	79	81	74	76	N.W.	
„ 25th	29·88	29·88	79	82	76	76	N.E.	Fresh E.S.E. scud, squally and heavy showers.
„ 26th	29·90	29·88	82	85	76	75	S.E.	
„ 27th	29·88	29·86	84	86	76	75	S.E.	Fine trade-wind, light clouds and clear.
„ 28th	29·82	29·80	85	87	76	76	S.E.	
„ 29th	29·80	29·77	84	86	76	76	N.E.	

takes place without being followed by a storm; nor is there any well authenticated case on record, where a tempest within or near the tropic was not preceded by a diminution of the pressure of the atmosphere. When the barometer is in good order, it will never fail to indicate the approach of a rotatory storm, the only kind that occurs, or at least that need be apprehended, in the tract of the trade-wind. In such a case, if the mercury falls half an inch below the height proper to the season, the vessel on board of which it is observed will very soon be under three-reefed topsails. It must, however, be understood, that it is from the relative depression of the barometer that indications of a storm are to be drawn, as the comparative height of the mercury in different instruments varies from half an inch to an inch. On board one ship it stood as high as 30.40, in another as low as 29.70. In the former case it would create surprise that a heavy gale was encountered with the barometer at 29.80, and with the other at 29.60 there might be no bad weather. In fact, three-fourths of the marine barometers that were shown to us on board of ships were almost useless. Some "work low," and some "high," it was said; therefore all that can be done is, to calculate from the ordinary standard of the instrument in fine weather.

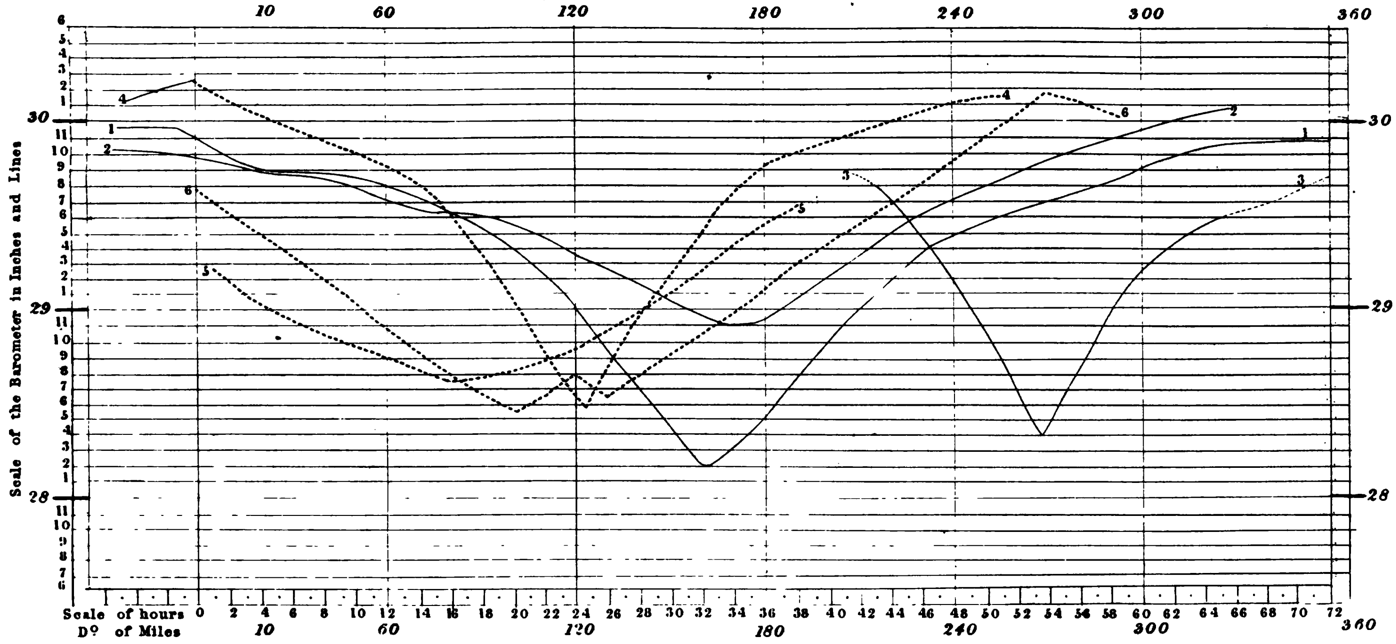
Not only is the passage of a hurricane over a particular spot invariably marked by a fall of the barometer, in a great degree commensurate with the extent of atmosphere involved in rotatory action, but the depression takes place in the same gradation from every part of the periphery towards the centre. At least the outlines of barometrical oscillations during storms all lead to this conclusion. In the accompanying diagram, No. 18, the fall and rise of the mercurial column during six hurricanes is traced along a scale equal to seventy-two hours, or 300 miles. The time and distance are computed on the supposition, that when in lat. 20° S. they move about five miles per hour, and generally take about seventy-two hours to pass. The continuous lines in this diagram represent the barometrical curve of storms observed at Mauritius, and the interrupted lines, of those experienced at sea by vessels changing their positions, in a more or less degree, while the vortex was passing; yet in both cases it is curious to observe the just proportion between the time necessary for the descent and rise of the mercury. The slight anomalies existing in the outline are referrible to errors in observation or calculation. In the storms observed at sea, the ascent of the barometer appears to have been very regular, simply because the vessels were either helpless or lying-to, and nearly equal to fixed points of observation. In the *Maguasha* storm, a slight irregularity is perceptible when the barometer is near its lowest range, but not more than might occur to any vessel moving to or from the centre. In the cases which are given in the diagram, the state of the atmospheric pressure *before* or *after* the tempests has not been obtained; indeed, it would seem that attention is only first directed to this point when a change of weather has advanced so far as to attract particular notice; hence we have only the range of the mercury near the vortex. But there is so much similarity in the general outlines of the barometric oscillations of every other storm, as well as those selected for examples, that it is impossible to doubt that they all follow a regular law.

It would seem that the depression of the barometer begins to take place by slow degrees from the extreme limits of the circle, but increases, in a sort of geometrical progression, as the distance from the focus is lessened; and near the latter position, the descent and subsequent rise take place so suddenly as to describe an acute angle. The concavity thus formed is exactly similar to that which is produced about the centre of a liquid body when subjected to circular motion. Supposing a mass of atmosphere of the same density throughout, and 28,000 feet in height, to be in rotatory action, the quantity of air removed from

PLATE. VIII.

DIAGRAM N° XVIII.

A SCALE SHEWING THE RANGE OF THE BAROMETER DURING HURRICANES



N° 1...Mauritius...Hurricane......of..........1836
„ 2.......D°............D°.........................1840
„ 3.......D°............D°.........................1824
„ 4...Exmouth.......Storm.........................1840
„ 5...Rodriguez.......D°.........................1843
„ 6...Maguasha.......D°.........................1843

the centre during an ordinary hurricane would be at least equal to 1000 feet; yet even in the actual condition in which it exists, the barometer often indicates a withdrawal of from one-thirtieth to one-fiftieth of the whole weight. At what altitude this takes place is a matter of mere speculation. The centripetal tendency at the lower surface of the revolving disc of atmosphere, and the extreme mobility of the higher regions, render it almost impossible for this to occur in either situation. It may therefore be inferred that the centrifugal agency throws off the rarefied air arising through the focal current at a moderate elevation from the earth. It is also suspected that near the margin of the circle the pressure of the atmosphere is somewhat above its ordinary standard: but to ascertain this, with any degree of exactitude, would require a much more extensive system of observation than has yet been made. In the *Exmouth* and *Maguasha's* hurricanes, there is some indication of this having actually been the case. The distance to which the atmosphere is partially affected by a hurricane is, apparently, so considerable as to escape early attention; so that when observations are first made on the state of the barometer, the extreme limits of the rotatory circle have passed. Few would imagine that the light and moderate, or even fresh breezes, that blow round the stormy circuit, are connected with a vortex which subsequently passes near to or over them. The fall of the barometer at Port Louis, when the focus of the Rodriguez storm was 300 miles off, was ·20, and the wind blew in conformity with the circle of which it formed a part.

But although the passage of a hurricane over a fixed point on land will be accompanied by a regular descent and rise of the mercury, it will seldom be marked by the same regularity on board of vessels, unless they are lying to. By remembering that the body of atmosphere distinguished by a temporary but prolonged diminution of its pressure, is an immense whirlwind from 300 to 600 miles in diameter, progressing from N.E. to S.W., its approach or departure will affect the barometer of a vesssel exactly as her course may be nearer to or away from the vortex, in proof of which a few cases may be selected for examples. In the Rodriguez hurricane of 1843, the *Velore* was scudding S.W., generally under close-reefed top-sails, in front of and along with the vortex, for the period of four days, and over a distance of 600 miles, with the barometer gradually descending from 29.50 to 29.20. On the 4th April, when she hove-to and allowed herself to be overtaken, it went down to 28.75 in *twelve* hours, and rose to 29.45 almost equally quick; but afterwards, by following the storm, it was several days before it finally regained its ordinary altitude. In the *Seringapatam's* storm of 1842, there is a curious instance of the rise and fall of the mercury as the ship lay-to behind or followed the vortex. The *Windsor*, in the gale of February 1836, having fallen behind it, was steering W.S.W. on the 29th, with the sympiesometer 29.25; on the 20th it was up to 29.42 by a N.N.W. course; on the 21st she changed to S.W., when it descended to 29.35; and next day, by again running N.W., it rose to 29.92. In 1838, the same vessel, while running S.W. after another storm, had the sympiesometer 29.42 during forty-eight hours; next day she scudded N.W., and had it up to 29.78, and fine weather. The *Malabar* ran S.W. for twenty hours, with the barometer at 29.60. The *Maguasha*, advancing N.N.E. to meet the storm, perceived a very rapid fall of the mercury.

Having been able to trace the direction, rate of progression, and diameter of the Rodriguez storm, with a greater approach to accuracy than any of the others, the diagram 19 (on the chart) has been constructed from notes made on board the *Velore*, when the storm's centre was passing. It is intended to exhibit the range of the mercurial column, and force of the wind as measured by the quantity of sail carried by ships at different distances from the focus. The scale is placed across the diameter of the circle in the line of its advance, but is equally applicable at any angle from the same line, supposing it to move round on a pivot at the centre. As the *Velore* hove-to on the beginning of the 4th April, and lay within a narrow circle till she sighted Rodriguez on the 5th, her true position may be calculated within a few miles of the truth. The state of barometer and winds were noted every two hours, as given in the table E. The diurnal motion of the storm at the period in question having been ascertained by other means, the probable distance of the vortex in approaching and departing from the neighbourhood of this vessel was computed for every two hours, and the state of the barometer at the time marked off along the scale. Although

TABLE E.

The state of the Barometer on board the barque VELORE, during the Rodriguez Hurricane.

	Date.	Hours of the day.	Barometer.	Wind.		Date.	Hours of the day.	Barometer.	Winds.
	1843					1843			
Running before the gale.	April 1st	Noon.	29·50	S.S.E.	Following the storm.	April 5th	10 P.M.	29·	N.W.
	„ 2d	Noon.	29·40	S.E.		„ „	12 „	29·45	NW by N
	„ 3d	Noon.	29·30	E. by S.		„ „	4 A.M.	29·45	„
	„ 4th	2 P.M.	29·20	„		„ „	8 „	29·40	„
	„ „	4 „	29·	„		„ „	12 „	29·35	„
Hove-to.	„ „	6 „	28·96	S.E. by E.		„ 6th	8 P.M.	29·30	N. by W.
	„ „	8 „	28·90			„ „	8 A.M.	29·50	N.
	„ „	10 „	28·90	S.E. by S.		„ „	Noon.	29·50	„
	„ „	12 „	28·85	S.E. by E.		„ 7th	„	29·56	SW. by S.
	„ „	2 A.M.	28·80	S.E. by S.		„ 8th	„	29·56	
	„ „	4 „	28·75	S. by E.		„ 9th	„	29·65	S.W.
	„ „	6 „	28·75			„ 10th	„	29·80	NW by W
	„ „	8 „	28·85	S.W.					
	„ „	10 „	28·85	„		April 25th at Port Louis		29·95	
	„ „	12 „	28·85	SW. by W					
	„ 5th	2 „	28·80	W.					
	„ „	4 „	28·90	W. by N.					
	„ „	8 „	28·92	W.N.W.					

this has been deduced from the observations in detail, it is found to correspond in a very remarkable degree with the relative height of the barometers on board of other vessels, at every part of the circle, both before and after the two days in question. Even the *Velore,* although out of the gale, hung on its skirts for five or six days after it had passed, and the state of her barometer, and her proximity to the focus of the storm, are found to be in perfect accordance with the results obtained from her previous observations.

Had the other vessels exposed to the Rodriguez storm been in possession of good barometers, and noted their changes with as much care as was observed on board of the *Velore,* a very valuable mass of information on this head might have been obtained, and the permanency and extent of the loss of atmospheric pressure might have been satisfactorily established in the various stages and situations of the hurricane. Inquiries were made on board of every ship for notes on the state of the barometer, but we found one half without this valuable instrument; in others it proved to be so out of order that no reliance could be placed on observations made from it; and in the few cases where it was tolerably correct, some isolated and unconnected remarks, made perhaps once in twenty-four hours, were all that could be obtained. The concurrent testimony of these last, in support of those of the *Velore,* which have been reduced to a diagram, makes it more annoying to have lost an opportunity that may never occur again, where so many ships accompany a storm over such a distance of ocean.

Allusion has been made to the probability of the axis, or, more properly speaking, the focal current, having in some instances, if not in all, an inclination from the perpendicular forward in the direction of the line of progression.* There is something in the *Velore's* observations that almost confirms this supposition, or at least shows that the centre of maximum depression is somewhat in advance of the aërial focus, or point, around which the wind blows on the surface of the earth. The circumstances which lead to this inference are thus explained. According to the rotation of the Rodriguez storm,* and its movement being from N.E. to S.W., it follows that a vessel on one side would have the wind at N.E., and on the other at S.W., when the focus of the storm was on that part of the central path nearest to them, at which time the barometer ought to stand at its lowest range. Now the *Velore* was a little to the westward of the storm's track on the 4th April, when the vortex passed her, and she had the wind from S.E. to south, S.W. and west. By reference to Table E, we find that the barometer was at the maximum depression about 4 A.M., when the wind was at S. by E.: and four hours after, when it was round to S.W., and her true position at right angles with the central path and nearest to the aërial focus, the barometer was rising. As the storm was travelling at the rate of five miles an hour, and the mercury was at its lowest range for the space of four or even two hours at the very least, before the arrival of the vortex, the result is obvious. The practical importance of having this problem solved by future inquiry needs no comment, and is a sufficient reason for hazarding a remark on the subject. We were led to observe this in drawing up the diagram 19, and have included the probable position of the focus of diminished pressure within an interrupted circle.

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* See Diagram 14, p. 164.

But there are other cases which corroborate these views, particularly that of the storm of 1836, observed at Port Louis, and to which reference has already been made. In the very complete observations on that hurricane, we find that the barometer was at its lowest range 28.230 just *before* the focus commenced; about the middle of the calm it was up to 28.255; and when the storm recommenced it stood at 28.325, or a difference of ·095 between the anterior and posterior margin of the focus. In the Mauritius gales of January, 1819, the greatest fall of the mercury was with the wind at S.S.W.; and in that of March, 1818, it was down to 28, with the wind E.S.E.; in both instances evidently being in front of the aërial focus, if we assume that these storms were moving in the direction which they usually follow when passing the island.

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* See Diagrams illustrative of this storm, and No. 19 on the chart.

Here it may be well to mention the maximum depression of the barometer in a few of the more remarkable storms which have visited the South Indian Ocean.

Neptune's storm	29.10
Rodriguez ditto	28.75
Maguasha's ditto	28.65
Exmouth's ditto	28.60
Mauritius hurricane, 1824	28.45
Ditto, ditto, 1836	28.23
Ditto, ditto, 1818	28.00

It must be inferred that a removal of the atmosphere to this extent near the centre, decreasing towards the exterior of a vast circle, and maintained for several weeks while a storm crosses the Indian Ocean, is entirely attributable to centrifugal action, arising out of a continuous application of rotatory motion. It, in fact, conveys a very correct notion of the effects of an atmospheric eddy, perfectly analogous to that of a fluid.

It has been observed that the mercury in the tube is, in certain parts of the storm, subject to sudden oscillations within the space of a few minutes, or even a continued motion upward and downward is said sometimes to have taken place. As this occurs near the margin of the calm, or where the atmosphere begins to ascend in sudden and spiral gusts into the focal current at the point of minimum pressure, it is not at variance with the principle of a regular gradation in the descent and rise of the barometer. It is even possible that a partial irregularity in the line of depression does occasionally take place from accidental causes. Yet it is surprising that when hurricanes pass over Mauritius, the height of its mountains does not appear to affect the currents of air, so as to influence the natural range of the barometer, on either side of the vortex. Whenever the atmosphere, owing to rarefaction, acquires an ascending power, it has a tendency to force its way through the upper strata, with an involute motion. This is observed to be the case whenever great fires affect the atmosphere. A few nights ago, during a fire which took place in the Chatham dockyard, we remarked that the volumes of smoke arose in a spiral manner, and showers of burning pieces of wood were borne aloft in whirling motion, round an axis inclining in the direction of the prevailing wind at the time. Air assuming a vertical motion near the focus of a storm, would naturally follow the same law, and rise in a number of miniature vortices round the general one, and thus account for those sudden, terrific, and almost incredible effects of the wind in hurricanes and tornadoes.

We cannot close this part of the subject without calling attention to the trifling fall that takes place in the barometer when the vortex is in lat. 25° or 26° S., compared with the violence of the wind. The *Windsor's* and other storms, given in the preceding pages, and that of the *Buccleugh* in the same latitude, would lead to such an inference; but more complete information is required before anything very decisive can be established on this important practical point. If it be as we suppose, it would indicate the vortical action in the higher region to be diminishing, as might be expected, in the situation where the specific character of the storm begins to disappear on the level of the sea.

The Sympiesometer.—The observations made with this very delicate and valuable instrument for measuring slight changes in the pressure of the atmosphere, have been so few and detached that we need not stop to notice them; but merely observe, that, in the few cases where the barometer has apparently failed, the sympiesometer steadily continued to prognosticate the approach of the storm. The complaint made against it is, that its range is not great enough, owing perhaps to the expansion of the hydrogen gas by the heat of the tropics; but when as low as it can be, a warning is given not to be despised. No ship traversing hurricane latitudes ought to be without one.*

Condensation of Vapour during Hurricanes.—Of all the phenomena developed during rotatory storms in the Indian Ocean, there is none more constant and remarkable, we may almost say awful, than the enormous quantity of water which is precipitated from the mass of atmosphere in agitation. For hundreds of miles on every side of the vortex, there is a dense stratified bed of clouds pouring out rain in torrents, without intermission. This process is continued for weeks, and appears to be a usual characteristic of the hurricane in all its phases, and over every tract of sea or land which it sweeps. The approach of such a storm may almost be prognosticated by the unbroken canopy of clouds which is slowly drawn over the sky, in the first instance at a great elevation, but gradually descending to the lower stratum, accompanied by an increasing gloom, till at last it rests on the earth and begins to deposit rain. At a distance of 200 or 300 miles in front of the vortex these indications are perceived, and would lead to the conclusion that the extent of the aërial commotion is greater in the upper than in the lower regions.

The absolute quantity of rain which falls has been ascertained on one or two occasions, at Port Louis, to be as follows:—

	Inches.	Lines.	Tenths.	Bar.
Mauritius hurricane of 1786...	6 ...	1 ...	24 ...	28.90
„ „ 1789...	8 ...	4 ...	24 ...	28.70
„ „ 1836...	8 ...	6 ...	60 ...	28.23
„ „ 1840...	10 ...	0 ...	90 ...	28.90

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* An account of this instrument is given in the Edinburgh Philosophical Journal, No. 1, and in the Edinburgh Journal of Science No. 20.

Even in the tropics these quantities are prodigious, and very nearly equal to one-fifth of the whole amount which falls over the island during the year. In the two last-mentioned storms the accuracy of the rain-gauge may be relied on; and therefore, by its concurrence, supports the results of the two former. Supposing the sphere of condensation to be confined to a circle of 300 miles in diameter, over which eight inches of rain fell in forty-eight hours, the whole quantity which would be precipitated within this isolated space, during 20 days, would be equal to 90 cubic miles of water, and sufficient to cover the superficies of Great Britain to the depth of five feet four inches.

Now it has been calculated by Sir John Leslie, that if all the aqueous vapour contained at one time in the atmosphere at the point of saturation was to be let fall at once, it would not exceed five inches in depth, or nearly that of one-eighth of the whole quantity which is discharged during a hurricane of 20 days' duration; in other words, from that body of air involved in rotatory motion, and moving along a distance of some thousands of miles. This clearly shows that a constant supply of moist air must have entered the circle of the storm; but as a very small portion of the whole vapour existing in the atmosphere can be separated at a time, the case presents itself in a much more striking light.

Although some obscurity still hangs over the exact nature of that process by which condensation of aqueous vapour is produced, it seems to be generally admitted that it is consequent on change of temperature. The vapour of water raised by the solar action, and wafted from one locality to another, is a most wonderful and important agent, particularly as a vehicle of heat from the equator towards the poles; still it is entirely regulated in its quantity, and in some degree in its movements, by the temperature of the air which absorbs it. While the heat of the atmosphere increases in an arithmetical ratio, the quantity of vapour which it will sustain at the point of saturation is augmenting in a geometrical progression. Hence, when two bodies of air, of different temperatures, each charged with vapour at the elasticity due to their heat, are mixed together, the mean temperature of the mass is that of the atmosphere, but is not sufficient to support the mean tension of the two bodies of vapour: the result is, that the excess is precipitated in the form of rain. But after the superabundant vapour descends, and the temperature of the combined mass of air is adjusted, condensation ceases, until another change of temperature takes place. Therefore, as the mean heat of the focus near the earth, during hurricanes, is about 76° to 77°, it follows that all the vapour which is reduced to the form of rain is the excess of two currents whose combined temperature is equal to this. Yet this excess is not great; for example, by Dr. Ure's tables* the

	Temp.		Inches of Mercury.
Tension of vapour at	70°	=	·726
„ „	80°	=	1·010
	—		——
Mean	75°	=	·868

But the tension of vapour at 75° is only ·860, and ·868 — ·860 = ·008 inches.

Thus the difference of temperature between two masses of atmosphere at 70° and 80°, even if at the point of saturation, would only yield a proportion of vapour to form rain equal to the tension of ·008 inches of mercury, or about equal to one-tenth of an inch of water, or one-fortieth of what falls in 24 hours. Therefore, to support the unceasing deposit of water from the atmosphere during these storms, it is necessary that two currents of air in opposite conditions should be constantly entering the area of condensation, and, on mingling together and yielding up the excess of vapour consequent on their reduction to a common temperature, should escape in some outward direction, to be replaced by fresh masses rushing in to undergo the same process. If one current only flowed into the circuit of the storm, the whole would quickly be brought to a mean standard, and vapour cease to be deposited; but by a steady introduction of two currents, under the circumstances which are inferred, it enables us to assign an intelligible cause for the incessant condensation going on, and the amazing quantity of rain which almost invariably distinguishes the rotatory tempests of the South Indian Ocean.

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* Ure's Dictionary of Chemistry.

During the Rodriguez hurricane not a single day occurs without one or more vessels repeatedly recording "incessant heavy rain," in these or other equally expressive terms. In every other storm similar observations are noted with great regularity. The fact seems to be unquestionable, and is strongly corroborative of the opinions already advanced, that two great winds in opposite states are constantly connected with hurricanes in every stage. Nothing, in fact, could be better calculated to bring two bodies of air in immediate contact, and facilitate their natural tendency to mingle together, than the rotatory velocity peculiar to these storms. An attempt has elsewhere been made to show the way in which the currents would enter and escape from the sphere of condensation.

Although we have so far considered the atmosphere as a homogeneous body, subject to be formed into currents by heat at the Line and the rotation of the earth on its axis, and, by certain temporary disturbances of the monsoon and trade-wind, liable to acquire a revolving motion, it is probable that the quantity of vapour existing in the air, and latent heat which it evolves during condensation, exert a very important agency in the complex process which constitutes a hurricane. As the proportion of humidity, however, is controlled by the temperature of the air, it is scarcely possible to regard it as more than a subordinate agency, developed subsequent to the gyratory action, and to a greater or less extent exerting a reactive influence on the mass of atmosphere from which it is separating.

The hot N.W. monsoon, constituted as has been seen, may readily be considered as the vehicle which unceasingly conveys aqueous vapour to the sphere of condensation. This wind loaded with moisture is, even on the level of the earth, invariably in communication with the N.W. side of the revolving circle till it has passed the tropics, and even then there is no case in which it has been satisfactorily ascertained that the S.E. trade has resumed its sway between the monsoon and that border of the hurricane; but, from the fact of storms beginning to lose their character and rate of progression at this point, it may be inferred that when the monsoon ceases on the level of the earth, its influence as the upper or equatorial current may be quite sufficient to support the stormy action as far as the latitudes, where it again resumes its former level as a westerly wind. But even in the early part of a hurricane, the influence of the monsoon, after it has risen to form the upper-current and overlaps the trade-wind, must be very important throughout the whole process. As heat is conducted downward through air very slowly and imperfectly, it is probable that the equatorial current in the higher regions of the atmosphere may possess a much higher temperature, and of course a greater proportion of vapour, than is generally supposed; while the lower and polar current, from the decline of the solar action at the season peculiar to storms, may be expected to be in an inverse condition. Hence the level of condensation may be considered to extend over a plane inclining from a great elevation, in front of the hurricane, till it touches the earth at some point behind it. Instead of the dark and equable canopy of vapour which precedes a storm, the sky behind it, even before the violence is over, clears up and is covered by rounded cumulous clouds, indicating a reverse condition in the upper regions of the atmosphere. By the precipitation of vapour at the junction of the two currents, the heat of the upper will be communicated to the lower. To what extent the air escaping by the focal current, and which may be supposed to join the upper wind and flow off to the southward, influences this, it is impossible to say; but that it does so in some way is more than probable.

It would seem that this violent adjustment of the heat and vapour between the upper and lower currents, going on at an elevation far above the earth, is particularly favourable to the formation of numerous small vortices or waterspouts. When the *Katherine Stewart Forbes* was approaching the Rodriguez storm, and began first to perceive indications of its vicinity in the increasing force of the wind, although still 300 miles to the S.E. of the vortex, she got into this unsettled kind of weather, and, to use the words of her officers, "was surrounded by waterspouts." The same thing is alluded to by the *Exmouth*, in whose log it is stated, on the day previous to the tremendous hurricane which she experienced, that they "*observed several clouds of a singular appearance pass from N.W. to S.E.*," and "*saw two waterspouts in the E.N.E.*" At the time she had a N.E. wind; but in twelve hours after had a "*weather and lee sea*;" no slight proof of the existence of *two* strong winds blowing near her: and in a few hours more the tempest burst over her in all its fury.*

In the process by which vapour is separated from the atmosphere during hurricanes in the Indian Ocean, the S.E. trade-wind may be considered as a vast refrigeratory to the hot and moist monsoon as a surface or upper current. It is possible, that on the level where condensation takes place, the difference of temperature between the two strata does not exceed 6° or 8°, and consequently would be insufficient to produce a copious fall of rain; but this will be compensated by the rapid and continuous introduction of fresh and humid masses of air, in equally dissimilar states.

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* Refer to Note 1, in the Appendix.

Thus the vapour, which in ordinary circumstances would be gradually deposited by the atmosphere over a wide region, is, by the peculiar action of the storm, drawn violently into a narrow and isolated area, and precipitated within a limited range, in quantities co-equal to the forces supporting the whole phenomenon. The vapour of the monsoon, in its stages from the vesicular state till it forms drops of water, and while sinking through the lower stratum or S.E. trade, will, by the liberation of latent heat, raise the temperature of the latter; and by expansion invest it with a power of ascending, in addition to that caused by diminished pressure towards the focus. It is even probable, that, by the rapid convection of the heat, thus extricated, upward through the focal space, the temperature of the whole central column or current is so regulated that condensation ceases and the sky looks "lighter;" and that this is carried far above the revolving plane of condensation surrounding it. In this manner the latent heat of vapour may, as a subordinate agent, add considerably to the upward tendency of the air created by loss of pressure near the centre.

There is yet another view which presents itself, in regard to the reciprocal influence of condensing vapour on the action of the storm. If the quantity of water raised by evaporation, and suspended in the current of the monsoon, does not add to its velocity, it at least partakes of its motion. In losing its buoyancy and sinking downwards, it will carry with it a considerable degree of this momentum, superadded to the law of gravitation, increasing with its conversion into a fluid, and materially augment the motion of the atmosphere through which it presses; but the heat given out during its descent would communicate additional elasticity and a vertical motion to the air. The antagonist force of the two, already subject to rotatory action, would tend to produce a horizontal direction of both round the circle, so that the falling rain and ascending air would meet; as the diagram No. 17 (Plate VII.) represents. This no doubt adds to the violence of the storm, perhaps even prolongs its duration, and assists in giving unity of action to the concatenation of phenomena developed.

There are some grounds for a belief that there is often a modification in the violence of a hurricane during the vertical action of the sun about noon; if this can hereafter be fully made out, it will indicate a much more important co-operation, arising out of condensation of vapour, than has yet been attributed to it.

Yet, in speaking of the effect of condensation of vapour, let us consider the enormous quantities of water which are precipitated from the atmosphere on the west coast of Africa, and other countries near the equator, without violent commotion of its currents, or anything at all to be compared to the extensive, prolonged, and terrible sweep of the hurricane, and it will tend to qualify the views which are entertained on this head. At a certain elevation all is clear and serene, and a cloudless sky reigns above the fierce contention of elements beneath. What this altitude is, it would be difficult to trace; but as it is stated in Hutchison's Meteorology that clouds are sometimes seen at the height of five miles, they cannot be much lower in the tropics, during the solstice, and with the atmosphere in vortical agitation.

The Temperature of Storms.—Very little accurate information on this head has yet been obtained, but as far as it goes it indicates a gradual fall of the thermometer from the commencement of a hurricane till near its centre, when a rapid rise takes place. In general the temperature towards the focus is about 76°, 77°, or 78°; and as this is about the mean annual temperature of the climate of Mauritius, the coincidence is curious. At the season when hurricanes occur the mean heat is 82°, and that of the day much higher. In the Mauritius hurricane of 1840 the thermometer was at 77° and 78° for thirty hours before the vortex arrived; but soon after the N.W. wind set in, although raining heavily, it quickly rose to 80°,—even at 10 P.M.

The Electricity developed during Hurricanes.—Among the phenomena attendant on tropical storms, there is none more wonderful or impressive than this mysterious agency of nature. At all times, and in all places, the display of electric fluid is very awful; but in the neighbourhood of the equator it is marked by a terrible activity, surpassing anything of the kind ever seen in temperate regions. This might be expected, from the tendency which it has to accumulate near the hotter parts of the earth. Yet, in a number of storms in the Indian Ocean with which we are acquainted, the presence of this subtle element has not been sufficiently active to attract attention; and, in general, it is so unusual to find thunder or lightning associated with Mauritius hurricanes, that by many their existence has been wholly denied. During the Rodriguez storm, however, these phenomena were developed on several occasions, and in connexion with other circumstances that gave them additional terrors.

There can be very little doubt, however, that atmospheric electricity is emitted, in a greater or less degree, during every hurricane, although it may occasionally escape observation. What the precise nature of the operations or changes which give rise to its evolution may be, is still wrapped in much obscurity, and is a question beyond our ability to cope with. It seems, however, to be generally allowed that it is in some way connected with the process of evaporation, and is such a usual concomitant on condensation as to be considered by a number of philosophers to be the cause instead of the consequence. The more ordinary causes which excite this element are chemical action, friction of bodies on each other, change of bulk and temperature, &c.

As it is easy to trace the existence of all these agencies in the atmosphere which surrounds our globe, it may explain the tendency which electrical fluid has to become insulated in different strata: for it is well known that a number of contiguous masses frequently exist in totally opposite states of electricity, owing to the very perfect non-conducting quality of dry air. As the parts of a homogeneous body subject to unequal degrees of temperature become diversely electrized, the cool locality assuming the positive or vitreous modification, and the warm the negative, it is concluded that the higher surface of our atmosphere is in the former condition, and the lower stratum in the latter, or the same as that of the earth. Nevertheless, in the ordinary state of things, the intermediate layers of atmosphere are generally supposed to be in different states of electrical isolation.

No sooner, however, does any agency, whether arising out of difference of temperature or motion, lead to the condensation of vapour, by which a conducting medium of rain or moist air between one stratum and another is established, than their electrical equilibrium becomes restored. Is it not more reasonable to conclude that even the formation of vapour, or at all events rain, instead of being the consequence, is the cause, or means, by which the opposite masses are enabled to communicate with each other? If this be correct, it prepares us to expect a vehement evolution of this element, in a vast circle of revolving atmosphere drawing in the neighbouring and dissimilar strata below, and after a rapid intermixture, attended by friction and change of state, throwing the whole off, by centrifugal action at a higher level.

When a body is charged with electric fluid, it retains the peculiar properties arising from this state, as long as it is completely isolated from others oppositely situated. Supposing a dry vitreous substance to be interposed between them, the insulation is very perfect, but no sooner has the surface of the insulator become moist than the difference of electricity between the two bodies disappears. Yet no one would venture to maintain that the humidity of the glass insulator was the effect of two oppositely electrified masses becoming assimilated. A cloud, separated from the earth by the non-conducting quality of dry air, remains in a state of isolation proper to itself, till moist air or rain extend through the lower stratum, and reaching the surface of the earth afford a medium by which the electricity of the former is instantaneously transmitted to the latter. In the hydro-electrical machine exhibited at the Polytechnic Institution, the rush of steam through a narrow orifice by its friction against the sides evolves electricity in enormous quantities, yet it is scarcely possible to suppose that this violent escape of highly condensed vapour is caused, or even accelerated, by the electric force. The high authority of Dr. Faraday is not favourable to this opinion, and he has further shown that water in evaporation is not adequate to explain the great excitation of electricity when steam escapes from a boiler.

It may also be inferred that the manifestations of electrical energy during a hurricane are consequences, perhaps, in some degree of the friction of vesicular vapour moving through the atmosphere, and capable of influencing the general process in a subordinate manner. The causes which support a violent rotatory action of many hundred miles of atmosphere must be continuous and equable. But the display of electricity is fitful, uncertain, and almost entirely confined to one side of the space embraced by the storm; nay, it is so little remarkable in many violent gales, that its absence altogether might almost be suspected; and in the hurricane of 1840 which passed over Mauritius, there was not the least indication of its presence at either Port Louis or Souillac.

Of the storms which have occurred in the South Indian Ocean, eleven have been accompanied by thunder and lightning, and in twenty-one others no indication of electricity was observed. The occurrence of this striking phenomenon is not likely to have often escaped notice. In the *Culloden's* storm, out of thirteen ships involved in it for several days, there is only one instance of electricity having been observed. Now, in the Rodriguez storm of 1843, its presence is noted in some of the logs on almost every day, except that on which it was passing over the island from which it is named. The following Table (F) gives an idea of the different points around the focus, where the evolution of electricity was most common and remarkable.

TABLE F.

A TABLE of the Electrical Observations during Hurricanes in the South Indian Seas.

Prevailing winds at the time.	During the Rodriguez storm.	During other storms	From the "Law of Storms."	Total No. of times.	Relative position to the focus.
From	No. of times.	No. of times.	No. of times.		
S. to W.	10	4		14	35 At the north or equatorial half of the stormy circle.
W. to N.	5	12	4	21	
N. to E.	4	1		5	7 At the south or polar side of the circle.
E. to S.	1	1		2	

This has been gleaned from the reports of storms, and it shows that electricity is five times more frequently seen on the north than on the south side of the storm, or in that part where the westerly monsoon predominates. Indeed, it has been so usual, during a passage from India to the Cape, to see "lightning in the north-west" ushering in a gale, that Horsburgh says the Dutch commanders of ships had instructions to shorten sail whenever this was observed. Even in those cases when the wind had easting in it at the moment when this phenomenon was perceived, it is generally reported to have been seen to the N.W. or north. Although lightning rarely becomes visible in hurricanes passing directly over Mauritius, it is very generally noticed when the weather indicates the centre of a storm to be to the S.E. of the Island, and the northern border or westerly wind is sweeping over it. As far as we have means of ascertaining the fact, it appears that the same analogy exists in storms of the opposite hemisphere, and that lightning and thunder generally prevail in the south half of their circuit, where a west wind also blows. In the Rodriguez gale, ships first began to experience these phenomena when they dropped round from the front to the after-part of the circle, and had the wind from S.W. to N.W. The *Margaret*, for several days before she got into this hurricane, was approaching it from the N.W., and, with westerly winds, constantly observed lightning at night. On the other hand, during the same period, the *Katherine Stewart Forbes*, while nearing the storm from the S.E., and with an easterly wind, had no signs whatever of electricity until entering the circle.

Now this is what might be expected to take place in accordance with our notions of the nature of a hurricane. The S.E. trade enters at the east side of the storm, and in its deflection round the circuit will, as a S.W. wind, come in contact with the N.W. monsoon, and, by mingling with it at this point, cause a deposition of vapour and an energetic manifestation of electrical force; and by the time that the united mass has moved round to the opposite side this will cease to be very remarkable. Of course this more directly applies to what takes place in the lower stratum, as the relative positions of the two winds in the upper regions will alter the locality where the two electricities combine. Even this seems to corroborate the theory of two winds being permanently connected with the existence of a hurricane.

It is certainly a curious fact that storms crossing the Mauritius are unaccompanied by electrical phenomena, and when the storm of April 1843 was over Rodriguez, only one vessel, the *Broxbournbury*, reports to have seen lightning. However, this vessel was 200 miles to the eastward of the island, while five or six others much nearer to it make no mention of any such phenomenon, although its presence is carefully noted both before and after that period. The only feasible solution of the question which offers itself is, that the lofty peaks of the mountains, rising far above the level of human habitations or observation during a storm, were the immediate conductors of the electrical fluid into the earth. This also is unfavourable to the theory of it being the primary cause of great tempests, for the rapidity with which the electrical equilibrium of the clouds and of the earth would be restored by means of these natural conductors, rising 2,000 and 3,000 feet from the level of the sea,* must necessarily affect the storm, at least below this altitude. But no such result takes place; the storm rages on the plains below the mountains with unabated fury, and apparently very little, if at all, retarded in its progressive movements. After passing over Rodriguez, Mauritius, or Bourbon, hurricanes are, if possible, even more violent than before.

It is worthy of notice, that while condensation is most abundant and extensive in the southern half of the storm, or towards the front, electrical phenomena are, as we have seen, in a great measure confined to the reverse portion of the circuit. This would indicate a less intimate connexion between condensation and the evolution of electricity than is allowed: hence we can only point to the fact as a subject for future investigation, and requiring more minute details in order to determine its precise value and extent; for of its existence, to a certain degree, there seems to be no doubt.

Causes have already been assigned which appear to us much more applicable to the whole of the phenomena developed during a progressive storm of a rotating kind than the mysterious and imperfectly known agency of electricity.

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* By means of such conductors, conjoined with a humid atmosphere, the electricity of the clouds and that induced at the earth's surface must quickly coalesce, and their force of attraction be annihilated.

Periodical abatements of Hurricanes.—In the course of this inquiry, various circumstances would lead to the conclusion that storms are subject to aggravations during the night, and temporary mitigation after sunrise. This may be attributed to the solar action on the upper surface of the whirling bed of clouds producing effects of too complex a nature to be easily explained. During the Rodriguez gale these periodical changes seem to have been made out on several occasions, but more particularly on the 7th of April, when, after a partial relaxation during the day, the wind, soon after sunset, was increased to a degree of violence surpassing even its former fury. This was felt by every vessel within the compass of the gale, but more particularly by those at the N.W. side of the vortex; even the *Velore*, 200 miles off, had the wind so much increased as to bring her under very low canvass. On this occasion the island of Mauritius was 250 miles to the N.W. of the storm's centre. Is it possible that the column of hot atmosphere formed over the land during the day was carried by the westerly monsoon towards the storm, and gave additional velocity to its motions?

Local influence of Land.—This has already been repeatedly adverted to, and leaves very little to be said. Nor is it a question that admits of an easy solution as regards the South Indian Ocean. The Rodriguez storm has some appearance of having been rather abruptly turned towards the tropics by that island, and its progression became much slower, while its violence was rather augmented; but as others also appear to decrease in their diurnal rate of progression in the same latitude, perhaps less is due to the influence of the island than would, on first consideration, appear to be the case.

In closing this review of the principal phenomena developed during rotatory storms in the Indian Ocean, south of the equator, and their connexion with the primary cause, it may be well to arrange the facts and inferences deduced from them, under a few succinct heads, as follows:—

1. Hurricanes only occur when the N.W. monsoon prevails between the equator and lat. 10° or 12° S., and more particularly during the retrograde motion of the sun from the tropic of Capricorn.

2. Their vortices are usually formed in the space of "variables" between the S.E. trade-wind and westerly monsoon.

3. The wind revolves E., S., W., N. around the focus, or in the direction of the hands of a watch.

4. Their course is south-westerly, generally from lat. 10° S. near the Indian Archipelago, to lat. 28° or 30° S., on the east coast of South Africa; and in the early stages the direction is W.S.W., curving to S.W. by S., or S.S.W. near their termination.

5. The diurnal progression of the vortex, when first developed, appears to be fitful and eccentric, but afterwards becomes steady; and is at the rate of 200 or 220 miles per diem, till about lat. 20° S., when it begins to diminish, and finally ceases about the limits of the trade-wind.

6. The fall of the barometer takes place gradually and equally on all sides, from the exterior edge of the disc of atmosphere in rotation towards the centre, where the point of greatest depression is to be found, or, occasionally, it may be a little in front of the aërial vortex.

7. The wind blows round the focus of the storm in a perfect circle for several hundred miles, but is felt at the circumference as a moderate breeze, increasing in vortical violence towards the centre, or point of maximum barometric depression.

8. In the middle of great hurricanes there is a space where the tempest suddenly ceases, and a dead calm prevails. At the margin of this area the wind blows with its most terrific force. In the early stages it is probable that the "calm" is very extensive, and embraces several vortices which gradually merge into one. As the vortical action

becomes more violent, and the storm moves towards the tropic, it is contracted to 10 or 15 miles in diameter, and continues narrowing till its termination.

9. Condensation of vapour seems to be co-existent with the rotatory action of the storm, and extends over a certain extent on every side of the focus, but is experienced much farther in front of, than behind, the vortex.

10. Electrical phenomena are generally developed at the equatorial side of the hurricane, where the westerly-monsoon predominates and forms a part of the circle.

11. A "cross confused sea" invariably accompanies a rotatory gale, and extends for 300 or 400 miles beyond the range of the tempest.

The following may be considered as hypothetical, but founded on the facts which have been adduced in the preceding pages.

12. The formation of hurricanes depends on certain accidental or local causes which tend to divert the motion of two adverse winds into a circular direction.

13. The continuous rotation and progression are attributable to the influence of the S.E. trade-wind and N.W. monsoon, blowing in contrary directions at opposite sides of the circle of atmosphere involved in the tempest.

14. The centrifugal action consequent on revolving motion withdraws air from the centre, and at the upper regions of the storm throws it off towards the periphery; and by causing a rarefaction of the air, a fall of the barometer takes place.

15. From the diminished pressure of the atmosphere near the focus, an up-current is established in the same ratio, and is supplied by the denser masses of air at the level of the sea rushing in from below, with a helical or gyratory motion; thus producing a centripetal tendency at the base, and centrifugal at the upper part.

16. The other remarkable phenomena seem to be consequent on the sudden and complete intermixture of the two adverse winds in opposite conditions with regard to heat, vapour, and electricity.

SECTION VII.

A REVIEW OF THE MOVEMENTS OF SHIPS IN AND ABOUT THE RODRIGUEZ STORM.

THE legitimate aim throughout this inquiry has been to arrive at some rational method of avoiding the dangers which are incidental to hurricanes between India and the Cape of Good Hope; and in order to the attainment of this important object, it may be useful to take a brief review of the separate movements of particular ships during a storm, prior to any attempt to lay down arbitrary rules for their future guidance. Individual cases often tend far more towards the elucidation of a subject than more full and extensive information in the abstract; and it so happens, that during the Rodriguez hurricane vessels were exposed to its fury in almost every situation which it is possible hereafter to occur. As we are better acquainted with the track and phases of this storm than any other, it offers a favourable opportunity of examining what other course might have been more advisable than that pursued by the different ships, in the trying circumstances in which they were placed.

We here beg most distinctly to disclaim any desire or intention to reflect in the slightest degree on the conduct of the commanders of the ships about to be noticed, but simply to employ their experience as a means of warning others how to act in similar dangers. There is reason to think that very few of those exposed to the Rodriguez gale had any true idea of its rotatory nature or line of progression; and even where some notion of this was entertained, it was not sufficiently clear to point out any efficient plan of escaping from the difficulties by which they were surrounded. Even if it had been otherwise, it is a question whether, in adopting a course by which the disasters attendant on the storm might have been avoided, but necessarily delaying their voyage for a few days, they would have been able to justify what would have appeared a useless precaution in the eyes of their employers. Be this as it may, ships persevered in running through the hurricane that lay on their homeward track, with more credit to the zeal and hardihood of their commanders than profit to the owners. The case of a ship being dismasted, and lying three months in Port Louis harbour, at a cost of many thousand pounds, is easily explained; but heaving her to, when under double-reefed topsails, for forty-eight hours, or running a hundred miles out of the direct course, merely because the barometer fell a little and the wind was veering in accordance with a hurricane, is quite another affair; even if that vessel came home without the loss of a single rope or spar, her commander, however judicious his proceedings, would, in all probability, find it difficult to reconcile them to the current ideas on such subjects.

In Section III. on the Rodriguez storm, the relative positions of the vessels were employed simply for the purpose of determining its character, extent, line of progression, &c. The manœuvres of each are now to be noticed. Had the hurricane been stationary, we might have traced out the courses of the several ships on the chart; but as they and it were moving along a track of 1500 or 2000 miles, every attempt to convey a clear notion of this has failed: however, in the succession of diagrams illustrating the Rodriguez gale, their positions at noon of each day will be found, and their intermediate course may be traced from the respective logs.

The Margaret.—This ship, with a wing of the 41st regiment on board, on her way from Bombay to England, having crossed the equator and track of the monsoon, seems to have approached the storm from the N.W., and got somewhat in advance of it. From lat. 9° S., long. 73° E., to lat. 13° S., long. 65° E., between the 27th March and 1st April, she had unsteady winds from S.W. by W. to N.W., with much lightning, rain, and sudden squalls. Steering S.S.W., she gradually neared the path along which the vortex was advancing, and, first encountering the S.W. wind, her passage was retarded till it passed ahead of her. At the same time she was running into its northern side, and had the wind veering from south to west and N.W., with "a very threatening appearance" and a heavy head sea. Her course being S.S.W., and that of the hurricane S.W., she gradually got into its northern and eastern border, and consequently behind it, with the wind at north to N.N.E., about the 3rd and 4th April. On the 5th her course was S.W., directly after the vortex, now moving onward more slowly; and with a strong N.E. wind she was again running obliquely into it, nearly in the same manner as the *Huddart* did in the *Culloden* storm.* Finding the weather rapidly getting worse, the vessel was hove-to, and began to drop out of the gale, and had the wind decreasing so much as to induce her commander to put up the helm, and on the morning of the 7th she was again scudding before a N.E. gale due S.W., towards the vortex; and in a few hours after was so completely crippled as to be left helpless, with the loss of rudder, fore and main yards, and lay like a mere log on the tempestuous ocean, till the violence of the storm passed on.

Had this vessel steered W.S.W. on the 3rd and 4th, when the wind was at north, she would have kept out of further danger, as we shall presently see was the case with the *Framjee Cowajee.* Again, on the 7th, when the wind was N.E., after having lain-to for several hours, had she hauled away to the N.W. for a day or two, such a course would have led her in the direction of the *Velore*, and she would have passed to the northward of the gale. Three months' delay at Port Louis would thus have been avoided.

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* See "The Law of Storms," by Colonel Reid.

The Robin Gray.—This barque, on her voyage from Calcutta to London, presents an interesting example of a vessel being in front of a progressive storm, and, like an *avant courier*, sailing before it for several days along the very path by which it was advancing. About the end of March, after leaving the monsoon, she had the wind gradually veering from W.N.W. to S.W. and S.E., and attended by the kind of weather characteristic of an approaching hurricane. While running about 200 miles in the twenty-four hours, the vortex came very slowly up with her. On the 29th March, in lat. 13° 20′, long. 72° 40′, she fell off to a west course, by which she gradually diverged to the N.W. of the central track, and had the wind creeping round from south to S.W. and west, accompanied by a "heavy head sea." She was thus delayed by the contrary nature of these winds till, on the 2nd April, the hurricane had arrived due south of her and passing onward, and, on the 3rd, it was round to north and N.E. Had this vessel now steered W.N.W., or N.W., and gone to the northward of the island of Rodriguez, she would have escaped the dangers which she subsequently encountered.

On the 3rd April, however, she steered due S.W., before a heavy N.E. gale, and traversing the eastern side of the circle, soon came up with and passed ahead of the vortex, now moving at so slow a rate that the heaviest sailer could easily overtake it. On the 5th she pursued a course more to the westward, and about noon, in lat. 21° 30′ S., long. 60° 45′ E., was crossing the path of the vortex, with the gale at *east*, "blowing to an awful extent," with a tremendous sea, and had her sails "blown to atoms." She now scudded under bare poles before the storm, veering from east to S.E. On the 6th she still continued to "keep right before it," and had the wind veering from S.E. to S.W., west, N.W., north, and N.E., in the short space of eighteen hours. She thus sailed, or rather ran, round the west side of the focus, crossed its wake, and again got up through its eastern side, and had nearly described a circle round the vortex, when a heavy sea threw the vessel on her beam ends, and during forty-eight hours she lay a mere wreck, drifting about at the mercy of the tempest and an overwhelming sea.

It is thus easy to perceive that a second opportunity was offered of avoiding the serious loss which this vessel sustained, by having kept away N.W., as soon as the wind was round to S.E., instead of scudding right before it. Had she even hove-to, with the wind at south or S.W. indicating her being to the N.W. of the focus, she would, in all probability, have dropped out without incurring harm. But by running east with the west wind, and then south and S.W., when it veered to north and N.E., she again placed the vortex exactly on her track to the Cape of Good Hope.

The brig *Argo,* from Sourabaya to Mauritius, was running west between the latitudes of 18° and 20° S. from the 30th March to the 4th April, with the wind at east and S.E., and appears to have been on the southern border of the gale, sailing parallel to its course. But on approaching Rodriguez, where the vortex began to turn more to the southward, she got on its path about the 4th April, and experienced the usual weather near the centre of a hurricane; and in twenty-four hours had the wind veering from S.E. to S.W., N.W., and N.N.E.; for this simple reason, that, like the *Robin Gray,* she continued scudding before the tempest, and described a complete circle. Had this vessel even pursued her proper course to the westward, or, still better, N.W., with the S.E. gale, she would have gone clear of it; but by a retrograde course she again placed the storm between her and Mauritius. On the 5th, with the gale blowing at N.E., she continued scudding

S.W. along with it, and was at last struck by a sea that laid her on her beam ends, and obliged her crew to cut away the main-mast in order to righten her. After this she was again steered before the wind to S.W., and as she passed ahead of the vortex, and found the wind changing to east and S.E., she a second time ran across the front of the storm; but on this occasion, instead of going round it a second time, she bore away N.W., and on the 7th April, in twenty-four hours, she got into better weather, and left behind her the tempest unabated in its violence.

The Rambler.—This brig, bound from Singapore to Mauritius, after leaving the Straits of Sunda, pursued a west course, like the last vessel, but a little more to the south; so that her track and that followed by the centre of the gale did not converge till both were to the southward of Rodriguez. She appears to have run into the eastern side of the storm; and with the wind blowing violently from E.N.E. was hove-to, within 40 miles of the focus, with her head at north to N.W., directly towards it. Thus she lay for *four* days, exposed to the severity of the gale, and drifting along with it. During this time the wind only veered from east to north, showing that, owing to the slow progress of the storm, she was nearly keeping up with it, and she evidently lay-to till her course to the westward was clear. Had not other vessels been in this storm, no one could have suspected that it was of rotative nature from the little change of wind felt by the *Rambler*. But at the time when she was driving along with the vortex, the *Robin Gray*, within a hundred miles of her, ran round a circle with the wind at every point of the compass, till at last, when near the *Rambler* and lying disabled, she had very little veering of wind.

Being on the eastern side of the storm, this vessel ought to have laid her head to the S.E., instead of N.W., and she must have got away from the danger in half the time that she did; or, what would have been still better, by running

100 or 150 miles to the S.E., and lying to, she would have been beyond the reach of harm till her path was clear.

The *Blanche*, on the 30th March, when in lat. 15° S., long. 73° E., and steering S.W., was in front of the hurricane, with the wind at S.S.E., and three reefs in the topsails; but by running more to the southward than the course pursued by the storm, she kept clear of immediate danger, and only experienced "heavy weather." On the 5th of April her course was changed to W.S.W., which led her across the route by which the vortex was progressing, and in lat. 23° S., long. 62° 28′ E., with the wind at E. by N., she was nearly in front of it. Having run more to the westward, and finding the weather tempestuous, the vessel was hove to with her head to the S.W., and the storm at S.E., and, like the *Rambler* on the opposite side of the focus, she lay driving along with it from the 5th to the 9th April, and with equally little variation in the wind. Had she run N.W., instead of lying to, a few hours would have sufficed to carry her out of the perils by which she was surrounded.

The Broxbournbury.—This once fine vessel, on her last voyage from Calcutta towards England, encountered the front of the hurricane as far east as 80°, and appears to have been more or less involved in it for a fortnight, as it was considered "a succession of gales." On the 28th and 29th March, with the wind south to S.E., she was running S.W. before the vortex, but found the weather daily getting worse, as it gradually overtook her. On the 31st, the storm was found to be changing to south and S.W., by which she was led somewhat to the northward of its central path, and, like the *Robin Gray* not far from her, had the vortex passing to the southward. When in this position, had she kept more to the westward, as the wind veered round to north, the dangers of her subsequent course might have been shunned.

On the 2nd April, being behind the vortex, the wind at

N.W. to north, and the weather improving, she steered S.W. by S., and rushed through the eastern side of the stormy circle, with the wind at N.E., but still at a sufficient distance to the eastward of the central path to have kept out of the way of the vortex, had she been aware of the true nature of the storm. On the 5th April her course was W.S.W. and west, or directly across the line of the storm's progression, consequently she had the weather increasing in severity, so that she was hove to exactly in front of the approaching focus. On the 5th and 6th she lay in this position, drifting partly along with and partly across the storm at east to S.E. After sustaining so much damage as to be in a foundering condition, it was discovered that she could "no longer lie to," and on the 8th was kept away N.W., before the gale. By continuing this course for twenty-four hours, she was in moderate weather, and, comparatively speaking, smooth water; and the log of the *Katherine Stewart Forbes* for that day will give an idea of the still unmitigated force of the tempest.

The *Sea Queen*, a fine and powerful teak built vessel, was on her voyage from Calcutta to London, when she encountered the Rodriguez hurricane, and like the *Broxbournbury*, is described to have suffered from a continued eries of gales for sixteen or eighteen days, between lat. 7° 58′ S., long. 82° E., and lat. 23° S., long. 60° E., although in reality it was the same progressive storm moving to the S.W. along with her; and by changing her position and distance from the focus, she experienced a corresponding difference in the force and direction of the wind. The storm was first encountered about the 25th and 26th March, in the usual situation at the contiguous borders of the N.W. monsoon and S.E. trade, in lat. 10° S., long. 81° E.; and this vessel seems to have been in that part of the trade blowing across the "variables" into the monsoon, as she had the wind veering from S.W. to south, and S.E., "squally, with heavy rain, gloomy weather, and a *long swell.*" Although steering before the vortex, it was five or six days before she was overtaken by it on the 1st April, when it appears to have passed over her, but without inflicting any damage more serious than splitting a few sails. This may be accounted for by the rapidity of its motion not allowing time for the tremendous cross sea, described to have marked the slower stages. With the wind veering round the compass, she fell behind the storm, and had its true character been known, by keeping to the westward and passing to the north of Rodriguez, like other vessels alluded to, she would have escaped the all but fatal encounter which awaited her to the southward of the island.

As in every other case, however, when the gale went round to north and N.E., she steered S.W., and passed the storm well to the eastward of the vortex; and from its diminished rate of daily progression, had this course been continued, she would in all probability have got far enough in front to run across its path without getting involved in any very serious danger. On the 4th April her course was changed to W.S.W. and west, which rapidly brought her in contact with the most severe part of the storm; and on the 5th she was hove to, with the wind at E.N.E., and her head to the southward, and lay during the 6th as if waiting for the focus of the storm, which came up with her on the 7th, and passed over her a second time. On this occasion she lost her masts, boats, bulwarks, rudder, &c., and was left in the wake of the vortex, a mere floating wreck.

But even as it was, had she continued scudding west or N.W., instead of heaving to, she would have gone out of the gale, as the *Broxbournbury* and *Argo* did about the same time; and although she would have had a few days of contrary winds on the N.W. side of the storm, it would have been a trifling delay, compared to some months in Port Louis harbour, to say nothing of the expenses to the owners and loss to the underwriters..

The *Velore*, a large, fine, and light ship, from Calcutta to Mauritius, was running west, and from the 27th March, when in lat. 11° S., long. 81° 41′ E., appears to have been scudding before the storm at the rate of 200 miles a day, with three reefs in her topsails, the wind at S.E., and every indication of an approaching tempest. Being a fast ship, and steering S.W., occasionally close-reefed, she kept ahead of it till the 4th, when, her course being west, the weather became so severe that she was hove to a few miles to the southward of Rodriguez, exactly in the way of the approaching vortex; and with the wind at S.E., "blowing the sails from the gaskets," and veering to S.W., west, and N.W. in twenty-four hours, she lay till the violence was past. After lying to for forty-eight hours, she attempted to continue her voyage to Mauritius, but was delayed by the westerly winds at the northern side of the circle. This, however, is an inconvenience which every vessel keeping behind a hurricane must be exposed to, but is slight, compared to the injury sustained by those that rushed S.W., into the heart of the tempest. But although the *Velore* escaped without severe loss, had she continued running westward, instead of lying to just as she got to the very worst part of the gale, it would have been still better.

The Katherine Stewart Forbes.—This vessel, deeply laden, after leaving the Straits of Sunda, on her way to England, seems to have been on the S.E. border of the hurricane about the 28th March, when in lat. 15° S., long. 86° E. Here she "encountered a fresh gale, dirty weather, heavy squalls, shipping seas over all," and "carried away some sails," but appears to have diverged from the westerly track of the vortex in that latitude. From this time she was running west, with fine trades and beautiful weather, and appears to have been so well to the southward, that, although sailing nearly parallel to the course of the hurricane, no further signs of it were noticed till about the 7th April, when, in lat. 23° S., she again found the weather getting wild and threatening. Had this vessel been a faster sailer, after separating from the edge of the tempest in 86° E., she would, by a straight course to the S.W., have kept ahead of it, and avoided all danger. As it was, she found the hurricane, after describing the usual curve towards the S.W., intercepting her course to the westward. With the wind at E.N.E., rapidly increasing as she entered the east side of the storm, she ran, in the course of forty hours, from fine weather into the very centre of danger, and, when in front of the vortex, hove to for the space of two days, till it swept over her with nearly fatal consequences. On falling behind the storm, and the weather beginning to improve, she attempted to continue her course to S.W., but, finding the gale increasing, she finally bore away for Port Louis.

If this vessel had had a barometer on board, and known the true nature of the storm, she might have shunned the danger by lying to on the first indications of its neighbourhood being perceived, and when the wind veered to N.E., by hauling up to the N.N.W., she would have got behind the vortex, where the westerly winds might have delayed her for a day or two, but she would have escaped the damage which obliged her to put into Mauritius.

The *Waverley*, like the last ship, coming from the eastward, entered the east side of the hurricane, and as she reached the centre found such weather as induced her to let out all reefs, and soon after she was dismasted and dropped behind it. She was two days in advance of the *Katherine Stewart Forbes*, and had the same opportunity of keeping out of danger, before she got too far into the storm, by heaving to till it moved out of the way.

The *Framjee Cowajee* seems to have been the first vessel that came in contact with the focus of the storm, and we regret not having made fuller extracts from her log on that occasion. But afterwards when, by comparing the notes in our possession with others, we discovered their relative importance, it was too late to obtain further information. On the 28th March this vessel was in lat. 12° S., and long. 80° E., when she encountered a gale with "heavy *confused sea, constant rain,*" and squally, wild, unsettled weather. At first she seems to have been rather in front, and had the wind at E.S.E. to S.E., gradually shifting round to S.W., west, and N.W., as the focus passed to the southward of her. She continued in the wake of the storm, with winds at N.W. and north, till the 3rd and 4th April, when it turned to the S.W. At the same time her own course to Mauritius being west, led her to the northward of Rodriguez, by which, perhaps unconsciously, she avoided the dangers to which a S.W. course would have exposed her. However her voyage was retarded for nearly a week between that island and Mauritius, owing to the west and N.W. winds prevailing at the time, in compliance with the rotation of the vast circle of which they formed a part.

The *Surat Merchant, Parland,* and *Wellington* were all behind the Rodriguez storm, but being bound to Mauritius, and steering a *west* course, with the wind northerly and westerly, they never got into the hurricane, although near enough to suffer from the sea which it left in its wake. We have seen that the *Margaret, Robin Gray, Broxbournbury, Sea Queen,* and *Blanche* were all at one time left in the after part of the gale; but being on their voyage to England, and their course to the eastward of Rodriguez, by running S.W. they overtook the vortex and hove to in front of it. In the *Culloden, Blenheim, Buccleuch,* and *Neptune* storms, the vessels appear to have been also homeward bound, and ran into danger exactly in the same way as most of those in the Rodriguez gale. All these cases tend to the conclusion that hurricanes, after passing lat. 20°, become so tardy in their diurnal progression, that vessels might with care run round the circle, and even in front of it, as the *Argo* did in the Rodriguez gale after she had lost a mast, while the other vessels, still uncrippled, hove to, and were soon worse off than the brig.

The *Carnatic* and *Prince of Wales* are good examples of ships following, and for several days keeping in the *after* part of a hurricane during its rapid stages, till finally left behind; while in that of Rodriguez others were running for the same period in front, and were gradually overtaken by it; but towards the termination of some of these storms, when their progress is slow, vessels come up with and pass them unhurt, unless they get into their vortex. Thus the *Windsor*, in the storms of 1841 and 1838, when to the southward of Mauritius, ran up to and passed through the northern half of the circle; and in 1836, nearly in the same latitude (26° S.), the same ship overtook and went round in front of another rotatory gale, in the same manner as the *Argo*, already alluded to. The *Maguasha* is an instance of a vessel running N.E. directly to meet the storm. Had she kept to the N.W. when the barometer and weather warned her of a gale, she would have avoided the neighbourhood of its focus. The *Malabar* is an opposite case, where, in following the hurricane, the coast of Africa forced her to steer so much to the southward as gradually to separate her from it. The *Siam* furnishes an example of a vessel, on her voyage to India, meeting with a hurricane while traversing the latitudes of the S.E. trade-wind.

SECTION VIII.

SUGGESTIONS FOR AVOIDING HURRICANES IN THE INDIAN OCEAN SOUTH OF THE EQUATOR.

FROM the broad wake of former storms, which stretches across the Indian Ocean, it is scarcely possible to suppose, that of the hundreds of vessels daily traversing it in every direction, all of them can shun the hazard of being intercepted by, or otherwise coming in collision with some of these periodical and perilous commotions of the atmosphere; and in spite of all human foresight and precaution, accidents may in consequence take place. But it is to be hoped that, by officers in command of ships paying attention to the subject of storms of a rotatory nature, and recording their experience, some system may be matured by which the number of such casualties may be greatly lessened. Even from what is already known, we think there ought to be no very great difficulty in discovering the prognostications of one of these fearful tempests, and by ordinary judgment and decision devising, not only to avoid being entangled in them, but, according to circumstances, by diverging in time from the path of danger, to prevent any unnecessary delay in their voyage.

Yet, we repeat, what is a few days' delay in a passage of three or four months compared to the risk of disaster, attended with loss of life and property, and subsequent detention, perhaps of months, in some port for which the vessel was never destined? Even conceding that occasionally an ordinary gale may be mistaken for the border of a vortical storm, the case is very little altered; do not vessels lie in the Downs for *weeks* together rather than face a westerly gale in the Channel? Why not also lie to for a *day* or two, or go a hundred miles out of the common track, to shun a danger exceeding any other which a vessel can encounter in the open ocean? In support of our views, we need but point to the long and annually increasing list of frightful calamities which have occurred in the neighbourhood of Mauritius. There are few who pass this island in the hurricane season without anxiety, justified by past experience; and all seek for some means by which they can confidently encounter the tempests that may suddenly intercept their homeward voyage.

Lights cannot float, nor buoys be anchored, to mark the treacherous region. Signals cannot be hoisted at every degree of longitude to warn the passing sail that a storm is nigh; but we believe that signs are to be seen in the heavens, and the clouds give forth omens that unerringly presage their coming anger. The very sea conveys on its heaving bosom indications, that can hardly be mistaken, of the fierce agitation going on even at the distance of many hundred miles. If these are not enough, there are yet other, and, if rightly applied, never-failing means of foretelling the hurricane's approach, by watching the prognostications of a *good* barometer,—a bad one is worse than none, because it deceives; and the sympiesometer is a still more certain and sensitive instrument for detecting stormy conditions of the atmosphere.

The preceding observations on the nature of hurricanes have been directed to one object,—that of adding, if possible, to our knowledge of, and thereby ascertaining the best method of avoiding them; yet we cannot enter on a subject of so much importance as laying down rules for the guidance of vessels without extreme diffidence, as it involves many nautical points with which a landsman cannot be familiar. As the Rodriguez storm is the most complete in its details, and its similarity to all others, as far as we know anything about them, is fully made out, it may with propriety be employed as the basis on which the directions for avoiding hurricanes are founded.

Commanders of vessels navigating the Indian seas south of the equator, will find that the only effective means of steering clear of, or contending with, hurricanes, are to be obtained by making themselves acquainted with their real nature. In possession of clear ideas on this subject, they will easily find out the most eligible course to pursue according to the diversified circumstances in which they may be placed; for it is obvious that general rules cannot be made applicable to every case. Besides, our present information regarding storms is not sufficient to justify arbitrary rules; and although their general character and line of progression is nearly correct, it is not only possible, but probable, that some storms may follow tracks considerably diverging from those with which we are acquainted.

As hurricanes are in a great measure confined to a particular period of the year, extending from December to April—perhaps a little earlier or later—it behoves officers in charge of ships, when between lat. 8° and 30° S. of the Indian Ocean, to keep a vigilant look-out for those indications which almost ominously foretell storms of a gyratory and progressive kind. The barometer, if in good order, will always warn the careful observer for several hours before the approach of danger. A slight fall of the mercury ought invariably to be attended to; and if it continues to descend slowly, but steadily, to the extent of even ·20 or ·30, particularly near the tropic, it will be time to consider the state of the wind and weather. If it goes down to ·50, or half an inch below its ordinary level, whether it takes place slowly or rapidly, the vessel will soon be under double or treble reefed topsails at least, and she may depend upon it that there is something threatening in her neighbourhood. However, the oscillation of the barometer will depend in some degree on the position and movements of a vessel in reference to those of a storm, according to the details given in the preceding sections, and which it is unnecessary here to repeat. When sailing in front of, or parallel to a storm in its rapid stages of progression, a vessel will find that the barometer does not alter its height very suddenly; but if she is hove to, it will be very different; in front, the fall of the mercury will be quick, and, if behind, the rise will be equally so. To the southward of Rodriguez and Mauritius, storms appear to move onward so slowly that vessels may, by running towards or from their foci, experience a corresponding change in the state of the mercurial column.

Next to the barometer, the direction and veering of the wind is to be observed. On leaving the monsoon a ship always meets with variable winds and unsettled weather, and here hurricanes are very likely to occur till she gets into the strength of the trade. When the N.W. monsoon veers in strong and steady breezes from west to S.W., south, and S.E., a vessel bound to Mauritius or the Cape will do well to keep a sharp look-out that she is not in the front of a circular gale following her to the S.W. If, on the contrary, the monsoon veers by N.W., north, and N.E. to east, she is in all probability on the after part of a storm, and has nothing to apprehend, except by overtaking it to the southward of Rodriguez or Mauritius. Although the *Carnatic* (at page 60) kept well up with a gale for four days, and some other ships have done something of the same kind, still there is no case of any vessel coming up with the vortex of a storm until it was south of lat. 20° S., unless in the case of the *Exmouth*,—a doubtful instance, and which, occurring, as it did, so late in the season, is an exception to the general rule, but nevertheless is sufficient to point out the possibility of coming up with a hurricane eastward of Rodriguez. The *Northumberland*, *Neptune*, *Blenheim*, &c., were all *overtaken*.

The veering of the S.E. trade to N.E. on one side, or south and S.W. on the other, must always be looked upon as very suspicious, and, in connexion with the state of the barometer and weather, may be sufficient to portend the vicinity of a revolving gale. Where the wind is round to N.W. or west within the ordinary tract of the trade, there can be little doubt about the matter. In the case of a vessel *in front* of a hurricane, when homeward bound, there will in all probability be very little change in the wind, which may continue at east to S.E. till the very vortex comes up with her; but the increasing violence of the wind and sea, together with the fall of the mercury and general aspect of the weather, ought to convey an ample warning of its approach and the direction of the gale will render it easy to avoid the danger. But a vessel will generally diverge to one side or the other before the storm actually reaches her. The Rodriguez gale furnishes some good examples of this kind. In particular, the wind experienced by the *Robin Gray* for several days, as the storm gradually overtook and passed her, went round the compass. Thus it was

S.E. on 27th March.
S.S.E. on 28th ditto.
S. by E. on 29th ditto.
S. by W. on 30th ditto.
S.W. by S. on 31st ditto.
S.W. on 1st April.
W. by N. on 2nd ditto.
N. by W. on 3rd ditto.
N.E. on 4th ditto.
S.E. on 5th ditto.

And in the course of the 6th she scudded right before it, and in twenty-four hours again had the wind round from every point, in the same manner.

It does not appear to require much ingenuity to ascertain the bearing of the vortex or centre of a circular storm, from a vessel, when the wind is found to veer in conformity with the known direction of its rotation. By laying down arrows, curving in accordance with the change of the wind, a segment of the circle of which it forms a part is obtained, and from thence the direction of the focus may be computed to within a point or two. The more rapid the variation, the nearer the vessel is to the centre, and the more easily is it discovered. This, in connexion with the barometer, violence of the gale, &c., applied to Diagram 19 (on the chart), may furnish ordinary information on this head.

But it very frequently happens that a vessel has no barometer on board, or it may be out of order, and, as in numerous instances given, she may be in a rotatory storm, and yet have very little variation in the direction of the wind. In such a case she must trust to the general appearances of the sea and sky, so repeatedly described and quoted from logs, in the preceding pages. Thick, dark, leaden-coloured, and unbroken clouds cover the atmosphere and pour out rain in torrents on every side of a storm's centre, and a "cross confused sea" is an invariable and necessary effect of a hurricane, and extends to many hundred miles on every side, generally far beyond the limits of the aërial violence. The *Katherine Stewart Forbes*, when nearing the Rodriguez storm from the eastward, experienced this cross sea 300 miles off, when still carrying studding sails.* If, therefore, a vessel falls in with such a state of the wind, weather, and sea as we have been describing, in the hurricane season and latitudes, she must judge of her proximity to the vortex by the quantity of canvass she is carrying, as laid down in Diagram 19.

If a vessel suspect or be assured of the vicinity of a progressive storm she must assume, till further knowledge is obtained, that its course is similar to all those which have already been traced. It is, therefore, obvious, that the two direct lines which lead out of danger are S.E. on one side and N.W. on the other, or at right angles with the path of the storm. But when a storm is encountered in about 10° or 12° S., its track being nearly W.S.W., although a S.E. course is correct and N.W. almost equally so, still, if apparently very near the vortex, N.N.W. will lead a vessel more directly away from peril.

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* See page 102.

It was a subject of keen discussion at Mauritius among the commanders of vessels who were in the Rodriguez hurricane, whether *lying to* or *scudding* is the more judicious course to be followed in a hurricane. Now it would seem that both are right and both are wrong, according to the circumstances of the case. For instance, the *Rambler* plunged into the storm on its eastern side, and heaving to near the vortex, drifted along with it for four days. The *Blanche* ran across the front of the gale, and at the moment when she ought to have run away N.W., she lay to, and continued for several days in the brunt of the gale. Had the one run S.E. and the other N.W., ten or twelve hours would have placed them beyond the reach of harm. The *Margaret*, *Sea Queen*, *Waverley*, *Broxbournbury*, &c. all scudded right in front of the vortex, and when at the point of greatest danger, instead of keeping to the west or N.W., they hove to and narrowly escaped, after sustaining extensive damage during an exposure of several days to the utmost fury of the storm. The *Robin Gray* and *Argo* scudded twice round the storm, and both suffered as much and were as long entangled in it as those vessels that lay to.

We are insensibly led to the conclusion that running *in the proper direction* is always right, as the quickest mode of getting out of the way of those casualties to which every vessel is more or less liable when hove to within the range of a hurricane, even although not in the very centre. The *Argo* and *Broxbournbury* afford instructive cases of how soon a vessel may run *out* of a hurricane, if she only follow the right path; and the *Katherine Stewart Forbes* is a converse instance of a ship rushing quite as quickly *into* one. Lying to seems more likely to be correct in the earlier stages of storms, when they move rapidly along their path, and may pass by a ship in twenty-four hours.

Or in the case of a vessel running west, and finding the torm right a head, instead of plunging into it, she may lie to for a day or two till it pass; or, what will appear better to an active-minded commander, he may beat up against the northerly and N.W. winds, so as to get round the northern side of the storm, as shown in Diagram 20 (on the chart). If the northerly wind tempt a ship to pursue her course to W.S.W. or S.W., the increasing force of the gale and confused sea left in its wake will be a caution how far she may venture in this direction.

So far the question has been, how a vessel is to discover the approach of a hurricane and shun its path altogether; but cases may occur where vessels unwarily or unavoidably find themselves deeply involved in its dangers before they adopt any measure for escaping from them. On such a supposition the Diagram 20 (on the chart) has been projected, as a simple mode of assisting those who have not had time to study the subject of storms in full. When a vessel is near the centre of a hurricane, it is of very little consequence how she got there; the point of vital importance is to find the speediest mode of changing her position to one less fraught with danger. The following notes in connexion with Diagram 20 (on the chart) are offered in the hope of their being useful, until more mature directions are obtained.

1st. With the wind at the intermediate points *between north and east* a vessel will find herself on the S.E. side of the storm.* If steering S.W., her course is parallel to that of the vortex, and there is every probability of her sooner or later getting into the most perilous part of the gale. She ought to haul away to the *south-east*, or, in our opinion, "turn tail to it," and scud 100 or 150 miles out of the way of mischief, till the barometer is well up and the weather better, when she may either heave-to, or work cautiously up against the N.W. winds. When a vessel is afraid to run, it is obvious that if forced to lie to, her head ought to be S.E., or as high as the wind, in veering to north, will allow. On resuming her voyage to S.W. or W.S.W. the barometer and wind ought to be carefully watched, to guard against the hazard of again entering the storm.

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* See the *Rambler's* log in the Rodriguez gale, and the vessels in the *Exmouth* hurricane, in Note 1, Appendix.

2nd. When the wind blows at E.S.E. or S.E. to south, a vessel is on the very path of the storm, and in front of the advancing vortex.* It is the most dangerous position in which she can possibly be, and is pregnant with disaster unless very decided steps are taken for escape. In the greater number of cases it will be found that ships run S.W. till they are in this part of the storm, and when the weather is almost at its worst, they heave to till the focus comes up and passes over or near them. This is no place for lying to, under any circumstances, without being exposed to the most imminent peril, and one which, from its longer duration, seems to be much greater than even that of running a crazy or deeply laden vessel. In the one case, the hazard may last for several days; in the other, a few hours will carry a ship to a comparatively safe place. As soon as the hurricane is at east, if a vessel is hove to with her head S.S.E., in the weather which we suppose, she will do little more than drift to the westward, right athwart the track by which the vortex is advancing. There is, in fact, but one alternative left when a ship has the hurricane between east and south, and that is to *scud west or* W.N.W. till the wind veers to south, then away N.W. (see Diagram 19), and never turn to the eastward till the foul weather is over.

These suggestions are chiefly intended for ships encountering this part of a hurricane about lat. 20° S. If they fall in with them in 12° or 15° S., the direction of the track of storms, being a point or two more westerly, or nearly W.S.W. (as shown in Diagram 19), a ship, in the circumstances supposed under this head, may venture to run S.S.E. with wind at *east*, but if it is as far as S.E. or S.S.E., the sooner she gets away to N.W. or N.N.W. the better; and, in attempting this, it must also be remembered that a storm travels very much more rapidly in 12° than 20° S.*

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* See the logs of the *Velore*, *Argo*, *Margaret*, *Sea Queen*, &c., in the Rodriguez hurricane of 1843.

In the critical position in question, the rise and fall of the barometer, in connexion with the veering of the wind and movements of the vessel, ought to be steadily watched, and will rarely fail to point out whether the steps pursued to escape from danger be correct or not.

3rd. When a ship has the wind at *south*, S.W. or *west*, she is to the westward of the storm, and has no difficulty in keeping out of its way. If homeward bound she has only to steer west, or, if the weather suddenly becomes worse, N.W., till she has reason to think the danger is past. It is seldom that vessels are found attempting to get to the eastward in the tract of the trade-wind, and consequently, of hurricanes; but such a course is occasionally followed by those trading between Madagascar and Mauritius, or from the latter island to Rodriguez. In such a case the storm will be felt at south or S.W., when, by keeping away north till the wind veers to west or N.W., a ship may then make a fair wind of the after half of the stormy circle.†

4th. At west, N.W. and N.N.W., the hurricane is past, and with such a wind a ship will be in its wake, and the only danger is in running S.W. after it.‡ Even this is not very great, till the storm has passed lat. 20° S. or arrived in the neighbourhood of the tropic of Capricorn, where its progression is so slow that any vessel can overtake it. It will, however, require no ordinary self-denial or rather moral courage on the part of an officer commanding a ship in such a situation to resist the opportunity of running

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* Refer to the *Argo's* log on 6th and 7th April, and *Broxbournbury's* on 8th and 9th April, in the Rodriguez storm.

† Also to the logs of the *Robin Gray*, *Broxbournbury*, and *Argo*, in the Rodriguez gale of 1843.

‡ See *Framjee Cowajee's* and *Parland's* logs on the same occasion, and the *Carnatic's* storm of 1838.

S.W. with a fresh gale at N.W. Nor is there any great objection to a cautious and intelligent commander attempting to continue his straight course S.W., provided he be guided by the wind, weather, and barometer; and, if the gale increases and veers to north, he is not to suppose that the danger is *behind*, but, on the contrary, feel assured that it is *ahead*. If, in such a case, the mercury is found to descend as the ship proceeds, it will be well to haul up west in time, and if the indications of bad weather still continue, she ought to be laid to or kept to the N.W.

Let the examples which have been given of vessels scudding S.W. with a N.W. wind veering to N.E., serve as a warning of what may be expected, when the weather, &c., indicate that a rotatory tempest is near.*

Of course it is not meant to put forth these remarks as arbitrary rules, but merely as suggestions arising out of the preceding inquiry. The data on which they are founded, and the reasons which justify their application to practical purposes, accompany them, and those who are liable to be placed in the circumstances which have been supposed, have an opportunity of judging of their correctness.

Vessels from India and the East, homeward bound, are chiefly exposed to hurricanes in the South Indian Ocean. A glance at the great track of these storms, as laid down in the chart, will at once explain how this occurs, and it will be seen that, from the time that a ship gets to lat. 8° or 10° S., or leaves the Straits of Sunda, she sails along a tract of ocean for 2000 or 3000 miles, darkened with lines indicating the traces of former tempests,—in all probability, till she arrives at the "Cape of Storms." Although hurricanes are encountered as far east as Java, and have occasionally been very fatal in their consequences about 10°

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* See the *Margaret's* log, on the 4th and 5th April, the *Robin Gray's*, on 6th April, and *Argo's*, on the 4th April, in the Rodrigues storm of 1843; also the *Windsor's* storms of 1841, and 1838, and *Seringapatam's* of 1842.

or 12° S., yet calamities arising out of them have happened much more frequently in the neighbourhood of Mauritius and Rodriguez than any where else. This may, with tolerable reason, be accounted for by their rapid progress in the former situation, not allowing time for the sea to rise to that violent and irresistible degree which characterizes their more southerly and tardy stages. A vessel from the Straits of Sunda, bound westward, by keeping well to the southward may sail for many days on the south limits of a hurricane and scarcely suspect her vicinity to danger till she meets it lying on her path near Mauritius. This seems to have been the case with the *Velore*, *Waverley*, and *Katherine Stewart Forbes* in the Rodriguez storm; the extracts from the log of the last vessel evidently testify that she had weather indicative of the proximity of a hurricane, at different points from the Straits of Sunda, for the space of a fortnight, till she actually came in contact with the vortex near Mauritius.

It is very rare to hear of a ship, on her way to India, falling in with, or at least suffering much from a rotatory gale in the tract of ocean which has been particularly brought under notice in these papers.* In consequence of running down their easting to the southward of 30° S., and when on the meridian of their destination, steering due north through the S.E. trade-wind, vessels cross the track which storms follow, nearly at right angles, and have scarcely time to sustain severe loss. Now this fact is a strong argument in support of the plan, which has been suggested to vessels homeward bound, whose course is parallel to that of a storm in which they may chance to be involved, of running away direct from its understood path, instead of lying to. If bound across the equator to the northern parts of the Indian Ocean, to the Straits of Sunda, or islands further east, a vessel may meet a hurricane from N.E. by east, to south or S.W., in which case the observations which have already been made on the means of avoiding or getting out of storms are equally applicable. But if the state of the wind and barometer indicate great proximity to the vortex, and the storm is at S.E., there is much caution requisite in running across its path, especially if it is met in lat. 10° or 15° S., and progressing fast; yet, if a vessel lie to with such a wind, she must inevitably drift west and fall into greater peril. It is a case which is not likely often to happen, but when it does, it will require great judgment on the part of the officer in charge, to decide on running N.W. or laying the ship's head to south. If the wind is east, veering to north, a S.E. course unquestionably ought to be followed, but if on the other hand it is as far round as S.S.E., it is equally clear that she ought to scud N.W. or N.N.W.

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* The *Siam* encountered the storm on her way to India, and the *Maguasha*, when steering N.N.E. to Sandal-wood Island.

When ships from the Cape of Good Hope are approaching Mauritius their course is about north, and they run some risk of meeting a hurricane.* Yet it is surprising how very seldom this takes place. In such a case, however, there seems to be no great difficulty in applying the directions which have been given for avoiding the vortex, according to the position of the vessel, and veering of the wind. As the ship will, in all probability, be well in front of the storm, and its progress will be slow, she may safely run to the N.W. till she has the wind round to S.W. and W.S.W., when she may calculate on its having passed, and bear up for her port. If she chances to be so far to the eastward, as to run S.E., in compliance with what has been advanced on this head, she will encounter westerly winds at the after half of the storm, and thereby will be delayed longer than by running in the opposite direction. But this of course must depend on the position in which she finds herself when the gale has declared its true character. If caught in a hurricane off the island the same rules hold good.

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* See the log of the *Gazelle*.

When ships are lying at the Bell buoy, at the entrance of Port Louis harbour, and are unable to get into the inner port, they generally slip from their anchors and put to sea on the approach of a storm. If the wind is at S.E. shifting to south, it will be most advisable to run N.W. till the weather is better or the wind veers to S.W. and west, when they may consider the vortex of the storm to be past and may return to their former anchorage, not too hurriedly however, as a heavy swell remains for some days after a gale.* When the wind at the Bell buoy is found to be veering from *east* to N.E. and north, it shows that the centre is passing to the westward of the island, and, on such occasions the hurricane throws a tremendous sea into Port Louis harbour. In this last case, ships putting to sea ought to run south till clear of Cape Brabant (Morne), and then steer S.E. till the weather is moderate enough to enable them to lie-to in safety.† In the hurricane of 1840, a vessel at the Bell buoy left her anchors, with the gale at S.E., hove to, and drifted from the island, but next day was carried back by the N.W. wind and thrown on the reefs at the entrance of Grand River, almost at the place which she left. Had she *run* N.W. for eight or ten hours instead of lying to, she might then have kept away till the weather and wind encouraged her to return; or at all events it would have afforded her sea-room.

So far as our information extends, with regard to storms near the N.W. coast of New Holland, in the Mozambique channel, and in the South Pacific Ocean, there is reason to think that they are conformable, in every respect, to those which frequent the great central track across the Indian Ocean. Therefore ships must adopt the same means of avoiding them, by keeping to the S.E. or N.W. of their path, agreeably to the position in which they may be with regard to the focus, and other incidental circumstances depending on the vicinity of land, currents, &c.

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* See extracts from the *Patriot's* log in Note 2 of the Appendix.

† Note 3, in the Appendix, in which it will be seen that some months after the above was written, but not published, the *Stag*, at Mauritius, followed and practically proved the correctness of the course herein recommended.

We have endeavoured to reduce these suggestions to as simple, clear, and concise a form as possible. Yet in all probability those who may turn to this part of the work in expectation of finding an easy and obvious method of escape from difficulties hitherto nearly insurmountable, without any effort of the understanding or exercise of the judgment, will be disappointed. Again we repeat that our object has been to point out the nature of these storms, and let commanders of vessels but make themselves thoroughly acquainted with this, and abstract instructions will be an unnecessary appendage to the subject.

SECTION IX.

ON THE PREVAILING OPINIONS WITH REGARD TO THE NATURE AND ORIGIN OF STORMS.

AERIAL COMMOTIONS IN GENERAL; EARLIEST ACCOUNT OF WEST INDIA HURRICANES BY LANGFORD; BY COLONEL CAPPER IN THE EAST INDIES.—MR. REDFIELD ON THEIR ROTATORY PRINCIPLE, CAUSES, &C.; MR. ESPY'S THEORY OF CENTRIPETAL OR IN-BLOWING ACTION AND ITS CAUSES; PROFESSOR HARE'S OPINIONS, AND THE ELECTRICAL ORIGIN OF STORMS; THE ELECTRO-MAGNETIC CAUSES INFERRED BY COLONEL REID, AND THE RELATION BETWEEN THE LINES OF MAGNETIC INTENSITY, AND THOSE SUBJECT TO HURRICANES.—THE ABSENCE OF SEVERE GALES AT ST. HELENA.—THE PROBABLE CONNEXION OF TWO OPPOSING WINDS WITH THOSE OF THE NORTH ATLANTIC, CHINA SEAS, COASTS OF INDIA, SOUTH PACIFIC, OFF THE CAPE OF GOOD HOPE, AND IN THE MEDITERRANEAN.

SEEING that the occurrence of great revolving storms in the Indian Ocean, south of the equator, has been strictly confined to a short period of the year contemporaneous with the prevalence of the westerly monsoon, and finding that they are not only first discovered in the interval between this wind and the south-east trade-wind, but actually move onward, if not for the whole, at least for the greater part of their course in the same relative position to these adverse currents, we were at once led to infer that their cause is such as has been attempted to be shown. The subsequent steps which have been taken to investigate the subject have strengthened us in this conviction. But the great principles on which the formation of a hurricane depends are universal, and, although more prominently developed within the tropics, will be found in a greater or less degree in every region of the globe. Hence we cannot help suspecting that vortical commotions of our atmosphere, from the mighty tempest possessing fixed characters and pursuing a definite course, to the thunder storm of the mountains, and temporary and undecided motion of the waterspout, all owe their origin to the opposing or angular action of atmospheric currents, and that the more remarkable phenomena which render them perceptible to our senses are the effects of rotatory action and centrifugal force. To pursue this question in all its details involves so many considerations that we are prevented from doing more than glancing at a few brief cases, out of the many which might be gathered from the records of aërial disturbances, that are [strictly concurrent with these views. A moment's reflection on the multiplicity of agencies likely to produce or divert currents of the atmosphere into adverse, horizontal, or vertical directions on the level of the earth, or in the elevated regions, will show that an almost endless diversity in the extent, permanency, and movements, as well as general effects, of the mass in rotation may be expected.

When the substance of the preceding papers were drawn up, with the exception of Colonel Reid's, we had no opportunity of referring to the general opinions which have been recently advanced on the "hurricane theory." But since arriving in England we have met with a few numbers of the "American Journal of Science" in the medical library at Fort Pitt, containing some exceedingly interesting papers on the subject of storms by Mr. Redfield, Dr. Hare, and others; but unfortunately the series to which we refer only commences at the middle of the discussion. Before closing this inquiry, however, it may be well briefly to advert to the views which seem to be entertained with regard to the nature and proximate causes of revolving storms.

It is a curious circumstance, that a subject which has forced itself on the attention of mankind in every age and country, should have so long eluded active inquiry, and been left in the obscurity, or at least uncertainty, which still hangs over it, while an even more mysterious, if not less interesting, but certainly not more important phenomenon—that of terrestrial magnetism—has attracted the scientific world, and secured for itself an extensive system of observation over the globe, such as can alone be expected to produce a complete knowledge of, and satisfactory theory of storms.

What important results may accrue from the study of magnetism, it is impossible to say; but our ignorance of this wonderful element has not, apparently, been associated with so many perils, or fraught with those memorable catastrophes which invest the history of storms with so much painful interest.

It is but very lately that the fact of rotatory action being proper to hurricanes, has been distinctly brought before the public; but, that the phenomena which prove it to be so have been known to observers in the earliest ages, is manifest in the inspired volume. It is clear that even the Roman poet's description of the tempest* by which his hero was thrown on the Carthagenian shore, was not conjured up by a fertile imagination, but evidently drawn from observation, and might be equally well applied to those of the present day in the same seas.

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* It would be difficult even in sober prose to give a more concise, vivid, and true idea of the conflict of winds in a storm, than that conveyed in the following lines :—

"South, east, and west, with mix'd confusion roar,
And roll the foaming billows to the shore.
The cables crack ; the sailors' fearful cries
Ascend ; and sable night involves the skies ;
And heaven itself is ravished from their eyes.
Loud peals of thunder from the poles ensue,
Then flashing fires the transient light renew ;
The face of things a frightful image bears,
And present death in various forms appears."

Æneid, i. l. 126.

There are many instances on record of the almost incredible violence of thunder-storms and other violent commotions of the atmosphere in Europe; but they have generally been limited to a narrow sphere of operation and of brief duration. It is within the tropics that tempests assume a vehemence of action over a wide range and for a prolonged space of time, which, with the frequency of their occurrence, make them objects of much greater apprehension than when they occur in temperate regions. The earliest account which we have of these seems to be that of Captain Langford,* in a paper on West India hurricanes, or rather "whirlwinds," as he repeatedly denominates them. He states that they begin at N.W. and end at S.E., and shews that the wind veers round the compass; and remarks, "that from N.N.E. to E.S.E. the easterly wind blows freshest, so does the W.N.W. to S.S.W. in the hurricane blow most violently." It is evident that he had some pretty correct notions with regard to their circular character, but mistook the direction of their progression, which he thought was in opposition to that of the trade-wind.

A century afterwards, Colonel Capper, in the East Indies, appears to have arrived at the same conclusion. We have not the means of referring to his work on the subject, but it appears that he only suggested the probability that storms would be found to be vast whirlwinds. Horsburgh also repeatedly alludes to the fact of storms being rotatory, particularly the typhoons of the China seas.†

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* Philosophical Transactions for 1698.

† "Horsburgh's Directions for Sailing to the East Indies," p. 203.

Professor Mitchell, "On the Proximate Cause of certain Winds," published in 1831,* expresses his opinion that the "phenomena of winds and storms are the result of a vortex or gyratory movement, generally of no great extent, especially in the region of the atmosphere where they prevail." Although it is not possible to agree altogether with this view of the subject, it sufficiently conveys the theory of circular action in stormy disturbances of the atmosphere.

Still nothing very definite or satisfactory seems to have been advanced on the nature of hurricanes till about 1831, when Mr. Redfield, of New York, established in a very conclusive manner the theory of their being vast progressive whirlwinds revolving round an axis, moving along a determined path. The very objections which have been brought forward against this opinion have been the indirect means of confirming the correctness of Mr. R.'s first opinions. If a doubt even remains, we think that the valuable and elaborate collection of facts given to the world by Colonel Reid, if read without preconceived hypothesis, ought to be sufficient to remove it. According to Mr. Redfield's inferences,† the storms "of the American coast may be traced to the N.E. of the West India islands, and are from thence drifted to the westward on a track which inclines generally to the northward till it approaches the lat. of 30° N., where their course is changed somewhat abruptly to the northward and eastward." He has made out their rate of progression to vary from twelve to thirty miles per hour, and that "the storm whirls or blows in a horizontal circuit, on a vertical or somewhat inclined axis of rotation, which is carried onward with the storm;" and that it is only in its magnitude that the hurricane differs from the tornado or lesser whirlwind. He also appears to have arrived at the conclusion that storms in the southern hemisphere revolve in a direction opposite to that in the northern. As we have not the means of referring to Mr. Redfield's discoveries in the detail, it is impossible here to do full justice to his labours.

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* "Edinburgh New Philosophical Journal," by Jameson. Vol. xi.

† Id. Vols. 24, 25, and 28.

But, notwithstanding our high admiration of the general accuracy and acuteness of this gentleman's observations, it is difficult to coincide with him in all his opinions, more particularly those which he entertains regarding the causes of hurricanes. He assumes that "the leading storms of the northern and western Atlantic, and the American coast, originate in detached and gyratory portions of the *northern* margin of the trade winds, occasioned by the oblique obstruction which is opposed by the islands to the direct progress of this part of the trade, or to the falling of the *northerly* and eddy wind upon the trade, or to these causes combined." The continuous causes of a hurricane in motion are explained in the following way:—"This progress still continues while the stormy mass is revolving round its own moving axis; and we can readily comprehend the violent effects of its unresisted rotation, while this velocity becomes accelerated by nearly all the oblique forces, and perhaps resistances, of the circumjacent current, or masses of moving atmosphere."* The direct force which sets the mass of air in motion during rotatory storms is said to depend on "the mechanical gravitation as connected with the rotatory and orbitual motions of the earth;" but we cannot clearly discover in Mr. R.'s arguments how this force is first converted into a rotating direction over a space of 500 or 600 miles, and kept up for several days while moving along a track of some thousand miles in length. If the rotatory action of the earth was alone sufficient to cause hurricanes, they might be expected at every season of the year, and ought to be more severe near the equator than beyond the tropics; even over a diameter of 600 miles the violence at the equatorial side would be greater than at the opposite point.

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* "American Journal of Science," by Silliman.

In a reply to that part of Dr. Hare's strictures more particularly relating to the absence of "continuous existing causes," in Mr. Redfield's theory, the latter gentleman observes, that "such forces are to be found in the continuous excess of atmospheric pressure which surrounds the hurricane, or aërial vortex." This excess we opine more properly means the relative difference between the atmospheric pressure at the margin and centre of the gyratory mass, equal in some cases to nearly two inches of the mercurial column, or as 30. to 28.; therefore, in reality, the excess which surrounds the aërial vortex is only the ordinary weight of the atmosphere, while the loss of pressure towards the centre is the effect of the stormy action. Hence the different heights of the mercurial column between one part of the hurricane and another, instead of a cause, is a consequence; and this loss of equilibrium would be restored in less than a quarter of an hour by the rush of atmosphere to the centre, unless continuous exciting causes existed co-equal to the disparity of atmospheric pressure. It is not to be imagined that Mr. Redfield alludes to that slight excess over the ordinary pressure of the atmosphere which is suspected sometimes to exist at the extreme edge of the stormy circle, for as this, even when observed, seldom exceeds one or two decimals of an inch, it is, as a cause, wholly inadequate to explain the depression of so many inches near the focus, and may far more correctly be considered as a partial effect of the general process.

The investigations of Mr. Redfield have induced him to adopt a theory of the trade winds, general currents of the atmosphere, and storms, which excludes the important influence of heat in rarefying the air and causing it to ascend above the cooler and denser strata in its vicinity, and as a matter of course, the influx of horizontal currents to replace it. The question is one which has long been settled by experiment, observation, and analogy; and, after severe scrutiny, the result seems to be unhesitatingly received by the most profound philosophers of the present age; and even if it was necessary to enter into it formally, the daily phenomena which are familiar to every one would suffice for this purpose. By refusing his assent to the agency of heat, Mr. R. has encumbered his theory with difficulties that must be insurmountable, and has exposed his opinions to the severe comments of Dr. Hare, who seems to have quickly detected and assailed the vulnerable points.

In the latest account* which we possess of Mr. Redfield's views the following remark occurs. "In order," he says, "to account for the supposed uniform character of the trade winds, a general theory of winds has been adopted, of much plausibility, founded on the alleged effects of calorific rarefaction in the equatorial region. Aided by successive emendations, this theory continues to receive the general sanction of the scientific world." This is accompanied by a summary of "facts and considerations," which, in his opinion, "serve to invalidate this calorific theory." As it is merely intended to notice, and not discuss the subject, our readers are referred to the article itself. His views on this head are still more clearly expressed in speaking of whirlwinds caused by great fires in the open air.† "We may perceive also in these cases how effectually the heated stratum of air nearest the earth's surface may be caused to penetrate a homogeneous body, and colder overlying stratum of current by means of the vorticular action,—a movement which is otherwise physically impossible, except in a partial degree by means of other concurrent movements, or of favouring circumstances."

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* "American Journal of Science," by Silliman, for October, 1843.

† "Edinburgh Philosophical Journal," New Series, vol. xxvii.

By this we are led to infer that rarefied air cannot ascend except by means of "vorticular action."

The rotation of storms in a particular direction is attempted to be explained by Mr. Redfield on the assumption that the wind blows in horizontal circuits round the great oceanic basons, and he exemplifies the case by the following experiment made on the surface of a common globe.* "Let a concave surface of wood or other substance, of a circular form and a diameter equal to five or ten degrees of the globe, be prepared, and perforated with a small hole in the centre through which a pin may be loosely placed to serve as an axis; then let the concavity be lined with flannel, or other yielding material, and placed upon the top of the globe near the equator; then cause the globe to revolve from west to east, in the direction of the earth's rotation, while the concave body is guided carefully by the pin at the axis in the direction of the storms' tracks, which are found on my chart of 1835, and so as to impinge with equal weight and surface on all sides of the pin or axis, and the incumbent body will be found to revolve from right to left, in the manner of the storms of the northern hemisphere." The result might naturally be expected in such a case, from the effects of rotation being greater at the equatorial side of the circular body moved along the surface of the globe. But a solid body fixed on an axis which is carried along by the hand in a determined direction, is wholly inadmissible as affording any analogous view of the effects of momentum diverted into a rotatory direction on a permanently-elastic fluid like air. Indeed, Mr. R., in replying to Dr. Hare, objects, with much justice, to the latter employing similar arguments derived from the laws of circular motion on a solid as representing those on air. But in one place it is alleged that the great horizontal circuits of wind which blow round the oceanic basons in one direction are produced by the earth's rotation, unconnected with the agency of caloric, and in another, the same cause is brought forward to account for the horizontal revolution of a vast body of atmosphere in a stormy condition, in a directly opposite manner, without any palpable cause for such a reversion of the primary laws of the universe.

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* "American Journal of Science" for October, 1843.

Another theory of storms has been brought forward in America, by Mr. Espy, which is not only opposed to that of Mr. Redfield in causes, but is absolutely at variance with the abstract facts derived from general observation, and independent of any hypothesis. According to this doctrine it is alleged that during hurricanes, the wind, instead of blowing in a circle, rushes directly from the exterior towards the centre to supply a vertical current under the influence of the suction power caused by the rarefaction and ascent of air from the extrication of the latent heat of vapour during condensation. This new and ingenious idea of the cause of storms has met with many admirers.

Now with regard to the rotatory motion of the atmosphere in great hurricanes, in one case; and direct in-flow which is said to take place, supposing the "centripetal theory" as it is called, to be correct, in the other; the question may be solved by direct observation, and, in our humble opinion, has been most decisively settled by Colonel Reid and Mr. Redfield. In the former case, if the line of progression is ascertained, the first half of the storm will be found to blow at *right angles* to and across the central path, in one direction, and the last half in the same manner, but in an exactly opposite direction; and in the latter, if the wind, as is alleged to be the case in the "centripetal theory" blows along lines converging towards the centre, it will be experienced at the beginning of the hurricane in a direction *parallel* to, and opposite to the line of advance, and after the focus has passed it will blow with it. Thus, in the Indian Ocean, south of the equator, where the ordinary course of revolving gales is from N.E. to S.W., they are found to commence at S.E. and end at N.W., but according to the "in-flowing" theory of Mr. Espy and his supporters, they ought to blow from S.W. till the centre passes by, and afterwards at N.E.,—a case that has never been observed at any fixed point of observation.

But it is acknowledged that a centripetal tendency exists at the surface of the earth in all storms attended by diminished pressure of the atmosphere towards the centre, for it is physically impossible that it could be otherwise. It is simply denied that the air rushes in straight lines from every point of the exterior of the circle to the focus; for if such was the case, a very few minutes would suffice to cause a cessation of the process, by restoring the loss of equilibrium between the different portions of the storm and circumjacent atmosphere. Nothing, in fact, but the centrifugal effects of *circular motion*, extending to a great elevation, are capable of presenting sufficient resistance to the lateral pressure of the surrounding masses, so as to preserve a cylindrical body of air in a state of isolation for a period of several days, with a diminution of weight equal to one or even two inches of the barometer. That a constant effort, arising out of the laws of gravitation, will exist to overcome this may be expected, and with greatest intensity at the level of the earth where a layer of the air will approach in a gyratory or helical direction, and towards the centre ascend in a spiral manner to replace that thrown off by centrifugal action at the upper part of the storm. Thus, in these elementary forces which constitute a hurricane, a certain degree of harmony must be present, else the process would end in the re-establishment of the normal condition of the atmosphere.

The cause which has been assigned by Mr. Espy for great storms is consistent only with the "in-blowing theory." But although it appears improbable that condensation of vapour could give rise to the rotation of atmosphere over such an extent as that exhibited in so many cases, particularly that of the Rodriguez gale, no one would deny that, as a subordinate agent, the heat liberated by this process is likely to exert a very important influence in augmenting the violence, or, perhaps, even prolonging the specific action on which it depends. The mere contact of two layers of atmosphere in hygrometrical disparity would tend to a gradual deposition of vapour, and extrication of latent heat, but from the limited action of their conterminous surfaces, by no means adequate to cause the incredible ascending velocity which must take place in a "centripetal storm," or even in the more sparing admission of air to the focal column in revolving gales. Some extraordinary motion of the atmosphere seems to be requisite to bring two such strata of perhaps 6° or 8° of difference in temperature together, and so thoroughly commingle as to deposit six, eight, or even ten* inches of rain in twenty-four or forty-eight hours. If the rapid condensation of vapour was to cause violent centripetal motion of the air, there would be no end to such commotions during the rainy season within the tropics, and, at least, every sudden and copious shower ought to exhibit some degree of this peculiar action; but in the "calms," deluges of rain fall with scarcely any perceptible horizontal movement of the air, which would necessarily take place if an up-current of any great velocity existed. But, on the other hand, violent rotation of the atmosphere can hardly take place without being accompanied by precipitation of vapour commensurate with the disparity of temperature between the currents entering it.

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* See Table A of the Mauritius hurricane of 1840.

But admitting that the latent heat disengaged during condensation is in such abundance as to raise the temperature of the air and cause it to ascend, and by a suction power to draw the neighbouring masses in horizontal currents towards the centre to supply the up-current, it almost necessarily follows that the sphere of condensation ought to be directly over the ascending column of air. This, however, is contrary to facts with regard to hurricanes passing over and near Mauritius, for in these the rise of atmosphere near the centre takes place from a space of ten or fifteen miles in diameter, over which the clouds cease to let fall rain, and so far from being denser, they are actually so light that the sun breaks through them, while the barometer is "fearfully low," and the pressure of the atmosphere is less at this than any other point of the storm; but on every side of this focal area, the precipitation of vapour, from a thick dark bed of whirling clouds, is unceasing. Supposing a condensing cloud did rest over the up-current, and its effects such as Mr. Espy represents them to be, there is a physical necessity for a continuous accession of humidity to sustain the process,—it must, therefore, either depend on some accessory force, or possess an inherent and self-inducing power, capable of attracting the adjacent strata within the range of its operation. The latter supposition is irreconcilable with any known principle, and if once set in activity the phenomenon might be interminable.

A powerful advocate of the "in-blowing theory of storms" is found in Professor Hare, who, in certain strictures intended to upset the rotatory principle maintained so ably by Mr. Redfield, has gone so far as even to deny the existence of some of the best established facts connected with our knowledge of storms. In the first place, he asserts that "the altitude of storms is well known not to be above two miles;" now it has been observed by Kæmtz, and others, that even the *lower* surface of storm-clouds pass above the highest points of the Alps, even over Mont Blanc itself. He even supposes that hurricanes in the United States pursue a very different track from that which Mr. Redfield and Colonel Reid have demonstrated. In another place he maintains that "the dead calm suddenly interrupting the fiercest raging of the storm from opposite directions is strikingly untenable,"* and appears to think that he has "demonstrated that in *extensive* whirlwinds the 'fiercest raging' cannot be suddenly interrupted so as leave a dead calm during the interval which takes place between two opposite winds."

In the preceding pages so many instances have been adduced of a dead calm of several hours' duration existing near the centre, and surrounded by "the fiercest raging of the storm," as to render it far more than probable that this phenomenon is an invariable concomitant on great revolving gales, and, perhaps, in a proportionate degree occurs in all vortical commotions of the atmosphere. At Mauritius it is always observed whenever the centre passes over the island, and is as familiar to the inhabitants as the tempest itself. It is in fact one of the most wonderful of all the phenomena developed by a storm, and, in our opinion, is a far more important key to a true knowledge of the subject than even the vehement manifestation of electricity, or awful deluges of rain, which leave a much more vivid impression on our senses. This calm between two opposite winds was also observed by Captain Grey during a violent hurricane on the west coast of New Holland,† and which is noticed in the Appendix to this work.

Although Dr. Hare agrees with Mr. Espy in thinking that the "centripetal theory," as it is somewhat improperly termed, is the true one, he entertains a different, and we believe old and still prevalent opinion, with regard to the origin of hurricanes, which he ascribes to electrical disturbance; yet he rather shows that this element is developed during storms, than how it can be a cause. He considers "the atmosphere as an electric in a hollow, globular form, and, as electricity is known to pervade the space beyond that portion of the atmosphere which is sufficiently dense, to insulate or perform the part of an electric;" the upper or outer surface of the atmospheric globe is equal to "a celestial electric ocean" in one condition, while the inner surface may be considered as a "terrestrial ocean" in an opposite state, and that "those enormous discharges of electricity which take place during hurricanes may be accounted for by supposing that they result from discharges between the celestial and terrestrial oceans."

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* Silliman's American Journal of Science for July, 1842.

† Journals of two expeditions of discovery in Western Australia, by Captain Grey, p. 336.

"The proximity," says Dr. Hare, "of a stratum of clouds electrified by the celestial ocean must cause an accumulation of electricity in any portion of the terrestrial surface immediately subjacent, and, by counteracting gravitation, cause a local diminution of atmospheric pressure, which is, it is well known, a precursor, and demonstrably a cause, of rain and wind."*

This, then, we presume, is the direct cause of the upcurrent and horizontal in-draft at the level of the earth. Granting that a cloud, thus electrized, acts by induction, and attracts to the surface of the earth electricity of an opposite kind, this would only last while the air was dry and non-conducting; but how long could this exist with torrents of rain pouring from the cloud to the earth, and the air demonstrably in a state of complete saturation?—certainly not for days, nor even hours. Certain forces seem to be favourable, if not absolutely necessary, to the evolution of electricity, such as motion, particularly friction of bodies on one another, chemical action, change of bulk or temperature, &c., all of which are traceable in the vortical action between two currents of atmosphere in opposite conditions. Is it not therefore quite as likely that the effect of the stormy gyration of the atmosphere is the electromotive agency, as well as the cause of the enormous quantities of vapour which are precipitated during hurricanes? While the air blows with tremendous and uninterrupted velocity, and even the rain is incessant, the manifestation of electrical force is only transitory, isolated, or confined to one-half of the circle, or often altogether imperceptible to observers.

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* American Journal of Science for July, 1842.

The hypothesis, thus put forward with all the talent of this eminent philosopher, implies, that in order to "counteract the laws of gravitation, the electrified stratum of clouds is floating over the focus, or ascending current of atmosphere. The objections which have been made to Mr. Espy's views are equally valid and applicable in the present case, namely, that in Mauritius hurricanes the densest clouds, which may be supposed to counteract gravitation and produce an up-current, are not over the centre of the storm, where, for fifteen or twenty miles blue sky is often seen, and no evidence of electric excitement is discernible; and if the sun be in the zenith he frequently pours down his rays uninterrupted by the dark masses of vapour encircling the horizon. But the very existence of such a state of things as Dr. Hare assumes to be the case, argues some other agency primarily in operation to form an electrified cloud adequate to produce the effects which he supposes, and establish a medium of connexion. It is hardly possible to believe that a storm or electrified cloud is *self-induced,* otherwise tempests would be unceasing.

It is not easy to conceive how an electrical mass of atmosphere, confined to certain tracts, can set in rotating motion a vast aërial disc of 600 miles in diameter, steadily maintaining the same, and dragging it some thousand miles in a fixed direction. For it is well known that electricity is most abundant, and even accumulates, in the neighbourhood of the equator; therefore, if it be the *primum mobile* in hurricanes, they ought to occur more frequently at every period of the year, and be more violent in that region than in the temperate zone; yet experience proves that great or enduring storms never originate or exist at the equator, or even nearer to it than ten degrees, from whence they generally increase in strength till near the tropics, where they unfold their most terrific powers. If hurricanes are supported in their specific action by the convective and disruptive discharges between the "celestial and terrestrial electric oceans" of our atmosphere, as alleged by Dr. Hare, we might naturally expect to meet with them as frequently beyond as within the tropics, and without reference to a particular season. But, although apparently only an effect of vortical action, it is probable that the electric force exerts an influence in some way subservient to the duration of the storm.

Of the many and indistinct views of the electrical theory of storms, certainly that of Dr. Hare's is the most comprehensive, and deserving of careful consideration. Although electricity be in some way connected with the evaporation and condensation of water, is its importance at once to be rated beyond the direct and ascertained action of caloric? Or, because aqueous vapour is raised in vacuo below the freezing point, and its ascent accelerated by electricity, is this the mightiest agent of nature, known as heat, suddenly to sink into a secondary element? The scale on which evaporation and condensation is carried on by the increase and abstraction of heat over the universe is the best answer to this. Even supposing the suspension of clouds depends on the vesicles of vapour being coated with electricity, each revolving on its pole, and mutually repelling one another, will any one deny that this beautiful arrangement would quickly be dissipated by a change of a few degrees of temperature? When the cold S.E. wind blows over the Table Mountain at the Cape of Good Hope, and touches at its lower surface the hot and humid body of air below and to leeward of the mountain, it causes a formation of visible vapour, which, by sinking down to the hotter part of the surface stratum, is redissolved, and becomes invisible. Thus, at one particular level, a cloud is constantly suspended while the cold wind continues; and few have passed this lofty mass of land without having witnessed the "table-cloth" drawn over it; the well-known indication of the S.E. current setting in.

The rotatory theory of storms has the support of Professor Dove, of Prussia, who appears to concur in many of Mr. Redfield's opinions, and considers this motion "as being a simple and necessary consequence of the rotation of the earth." But as the motion of the earth is uniform throughout the year, why is it that hurricanes in both hemispheres are confined to a few months when the region where they appear has arrived at the maximum degree of annual heat? Nor do they ever occur at the equator where the earth's rotation is greatest. But as a cause coefficient with the thermal currents of the solstitial seasons, this force must be recognised: it is merely objected to as the sole agent in tropical storms. He remarks "that* as West India hurricanes *originate at the inner boundary of the trade-wind*, where at the limit of the so-called region of calms, the air ascends and flows over the trade in an opposite direction, it is probable *that portions of the upper current penetrating through the lower one give the first occasion of those storms*. The high mountains of several of the islands, by offering a mechanical impediment, may be one cause of this effect, as the air flows with redoubled velocity between two mountains."

It would thus appear that rotating storms have their origin at the inner boundary of the trade-wind in the northern as well as in the southern hemisphere, and this very fact affords a remarkable coincidence in this respect, although we have expressed a different opinion with regard to the circumstances which primarily give rise to a revolving action of the atmosphere. It also seems probable that if storms were sufficiently low to be affected by the high land of the West India Islands in a "mechanical" manner, they would be impeded in their velocity, or broken up into numerous smaller vortices.

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* American Journal of Science for April, 1843, vol. xliv.

Another theory seems to be hinted at by Colonel Reid, by which their origin is in some way or another connected with magnetism, or rather electro-magnetism. He states that he was led to this conclusion from the fact of a hollow magnetic iron globe revolving in contrary directions when placed at the opposite poles of a voltaic battery. He "is impressed with the opinion that the force and frequency of storms may have some connexion with the law of magnetic intensity."* Further on he repeats, that in consequence of the isodynamic lines of greatest magnetic intensity passing through the Chinese seas and near the Caribbean Seas, he thinks "there must be some connexion between the magnetic intensity and the force of storms."

There is no doubt something very curious and interesting in the laws of electro-magnetic dynamics, as discovered by Œrsted, in producing contrary and helical motion on magnetic metallic bodies at the two poles of an electrical battery. The intimate relation between the phenomena of magnetism and electricity seems to lead to the general opinion that the former is only a modification of the latter, and they are so closely allied to caloric, that both theory and observation concur in showing that these elements are in more or less activity during vortical storms. But to consider them as primary causes is involving the explanation of a sufficiently obscure phenomenon in still greater difficulty by referring its origin to a far more mysterious agency. Besides, there are obvious objections to any reasoning which employs the effects of electro-magnetic action on a metallic and solid body, to exemplify the probable consequences of the same laws on an elastic fluid like air, on which the powers of magnetism are so feeble. Suppose, however, that a stormy mass of atmosphere was put in helical motion by magnetic forces, it is assumed that this must be conformable to and in communication with one of the poles of a terrestrial battery, and that this actually exists at that region of the earth where hurricanes are formed. But, even admitting that an electro-magnetic impulse equal to that of the most violent gyration is conveyed to a disc of atmosphere, it is scarcely possible to suppose that it would travel some thousand miles, endure for many days, and although isolated from its place of origin, would, notwithstanding all the resistances, friction, and inertia of the circumjacent masses which it would encounter, go on even increasing in violence, and without relation to the lines of variation, dip, or even intensity. If storms are magnetic phenomena, they ought to be more violent and better developed in the polar than equatorial regions. Their occurrence at a particular season is also against this supposed origin, as magnetic intensity is nearly equal all the year round; at least the periodical changes to which it is liable are too insignificant to be a cause of storms.

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* The Law of Storms, by Colonel Reid.

To show that this element is an exciting cause of rotative gales, it is necessary to trace some fixed relation between their violence and progression, and the ascertained lines of magnetic forces on the surface of the globe, beyond the mere fact of their revolving in contrary directions in the two hemispheres. With regard to the horizontal action of magnetism, it will be seen by reference to Hansteen's chart of isodynamic lines that hurricanes in the neighbourhood of the West Indies move nearly parallel to the American line of no declination; in the first instance crossing to the westward; and then recrossing, they proceed along the coast of the United States.

On the same chart the eastern line of no variation is found issuing from the N.W. coast of New Holland, and, passing to the westward of Java and Sumatra, it cuts the equator about 75° E. Now we find the Timor hurricanes formed to the eastward, and following a track which crosses at right angles to the westward of this line of no declination. The Java storms appear to be formed on this very line, and in their progress past Mauritius traverse the lines of increasing variation from .0 to 20°. The storms of the Mozambique Channel seem to originate in a situation where the magnetic declination is 10°, and move onward till it reaches 20° or 25°.

The modification of magnetic action which causes an inclination of the needle is still less observable as an influential cause in storms. This force is least at the equator, and greatest at the poles; the localities where terrific storms are most frequent is much nearer the former than the latter. Although the magnetic and terrestrial equators do not coincide, yet if the former is traced at its different points of divergence from the latter, it affords no clue to the prevalence of storms. When to the southward in the Pacific Ocean, it is near the tracks of the hurricanes which frequent the Society and Harvey groups of islands. Again, when it is found north of the natural equator in the Chinese seas, it is in a region prolific in typhoons; but on the same meridian in the opposite hemisphere, the storms which occur between the Indian Archipelago and New Holland are equally violent.

The isodynamic lines of the earth's magnetic intensity so very nearly coincide with those of isoclination or dip, that for general purposes they may be considered as being similar, and that this function of the needle increases from the equator. The intensity is found to be less in the southern than the northern hemisphere, yet storms are equally severe in both. The magnetic equator of the South Atlantic enters the continent of South America about lat. 15° S., and the curve of least magnetic intensity approaches it about lat. 20° S. Yet in this very region storms of a severe and destructive nature are experienced, and the pamperos of South America are as violent as the tornadoes of the coast of Africa, or typhoons of the Chinese seas.

By Colonel Sabine's latest contributions to the science of terrestrial magnetism, we find that—

Place.	Lat.	Long.	Total Magnetic Intensity.	Prevalence of Storms.
At Pulo Kumpal. .	2°44′S.	110°07′E.	1.128	Hurricanes do not occur.
Hong Kong . .			1.156	Do. frequent.
Seychelles . . .			1.034	Storms absolutely unknown.
Acheen Head . .	5°36′ S.	95°20′E.	1.040	Do. frequent and severe.
Amsterdam Island	20′	132°08′E.	1.097	No storms.
Cape of Good Hope			1.011	Subject to severe storms.
Majambo Bay. .	15°14′S.	47°00′E.	1.092	
St. Helena . . .			.805	Storms unknown.
London			1.000	

The absence of severe revolving gales at the island of St. Helena may be attributed to the low magnetic intensity of the place; but we attach more importance to the non-existence of another, and, we think, more obvious and ostensible cause, worthy of notice in reference to this subject. It is the fact of the S.E. trade in the S. Atlantic prevailing without intermission between the tropic of Capricorn and the equator throughout the year, as satisfactorily shown by Horsburgh.* During the solstitial season of the southern hemisphere, the westerly monsoon, which prevails for ten or twelve degrees between the equator and inner boundary of the trade, at almost every other oceanic part of the globe, is never experienced near St. Helena; occasionally, a westerly wind may be met with for a degree or two south of the equator, but so seldom that Horsburgh has fixed the border of the south-east trade wind in lat. 1½° *north*, from December to April, or hurricane season of the southern hemisphere, as the mean result of the inspection of 238 ships' journals. We think the absence of such a periodical westerly current of atmosphere and of stormy commotions in the South Atlantic, is so obviously the converse of what occurs in the same latitudes in the Indian and Pacific Oceans as to render the arguments in favour of its connexion with revolving tempests almost conclusive, and even the state of the winds in the North Atlantic coincides in this respect.

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* "Directions for Sailing to and from the East Indies," p. 25.

Whatever the remote cause of stormy disturbances of the atmosphere may be, it seems to be closely connected with the increased action of the solar agency peculiar to the season when they occur. And as caloric has a very marked influence in developing electricity and magnetism, these may be regarded as concomitant phenomena. The laws of gravitation and rotation of the earth being permanent, are no doubt important forces in hurricanes, but are merely subservient to the periodical agent. The calorific generation of new and temporary currents in a counter-direction to those of a fixed nature will, in all probability, be generally found to be the means by which those terrible conflicts of the air are produced. Such seems to be the case in the Indian Ocean, and there is every reason to think that the same laws operate in other parts of the globe. To enter into a detailed account of the various modifications and derangements to which these laws may be liable, is beyond our scope. The irregular configuration of the great continents, and surface of the ocean diversified by islands, under the annual movements of the sun, must give rise at certain seasons to winds at variance with one another, and with local peculiarities requiring to be investigated on the spot in order to discover the way in which vortical motions are formed.

A question very naturally arises—whether the formation, continuance, and progression of the great West India hurricanes are dependent on adverse currents, or can be satisfactorily explained by supposing the existence of such winds to be verified? It must be candidly confessed that we are not in possession of a sufficiency of positive data to demonstrate this; but negative evidence is favourable to the former part of the query, and analogy and the universality of natural laws tend to affirm the latter. A complete solution of this problem can only be obtained from cotemporaneous observations made at distances of many hundred miles on both sides of a hurricane's central path; and it is probable that such an inquiry has never been made. Indeed, in looking at Meteorological Journals of different parts of the globe, great inattention, or omission in noticing the prevailing currents of the atmosphere is perceptible, while its pressure, humidity, and temperature, are elaborately recorded.

A very great similarity exists between the state of the winds in the North Atlantic during the hot months and those in the Indian Seas south of the equator. Revolving gales are found to approach the West India islands and coast of the United States from the eastward, and, as Professor Dove says, are formed at the inner border of the trade wind. Now, according to the high authority of Horsburgh,* this border of the N.E. trade-wind, during the hurricane months, is in the mean lat. 12° N. of the equator; and in this tract of twelve degrees, southwest and west winds prevail, and constitute what is called the "Line Westerly Monsoon."† The local currents caused by the West India islands no doubt increase the range of this wind in their proximity. Thus, as in the Indian Ocean, there are found two contrary winds and storms issuing from between them; and as they are exactly in the reverse direction to those in the opposite hemisphere, so is also the course of their stormy gyrations. Even causes similar to those assigned as giving rise to vortical action of the winds in the Indian seas are also to be found in the projecting shoulder of South America, near Guiana, where southerly and S.W. winds prevail during the northern solstice, or even the West India islands may occasionally so disturb the limits of the two winds as to produce the same effects. The heated surface of the former land during the day might cause a portion of the N.E. trade to deflect to north and enter the monsoon, where its direction would further change to N.W., and the natural inclination of the latter from the equator, in a south or south-east direction, would complete a circle of revolving atmosphere, and, once formed between two such lateral currents, it would acquire a permanent action till it moved away from the means of support.

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* Horsburgh, p. 25.

† Horsburgh, p. 26.

In conformity with the ordinary effects of heat during the summer season on the atmosphere over vast continents, it is to be supposed that the regular trade-wind on approaching the shores of North America, encounters, at a greater or less distance inland, currents at variance with, if not directly opposed to it; and these, we believe, are from S.W. to N.W. The latter is said to prevail in Mexico with great violence at times, particularly between the autumnal and spring equinoxes. The same calorific action by which new and periodical currents are elsewhere set in motion, contrary to those depending on the rotation of the earth, will act with greater energy on the interior of continents than on the ocean, where it must necessarily be greatly subdued by the process of evaporation; and general observation confirms the theory. As no mean proof of this, the following remark of Mr. Redfield may be adduced, although brought forward by him as an argument in favour of a very different hypothesis. He observes, "that near the western borders of the Atlantic, and over the adjacent coasts of America, the opposite southerly and south-westerly winds of the circuit are often well developed at the earth's surface, *at least in the warm season.*"* Professor Mitchell also says, that "westerly winds predominate over those from the east quarter within the limits of the United States."

It would thus appear that the trade-wind in the North Atlantic blows uninterruptedly from within a few degrees of the coast of Africa to the opposites shores of North America; between it and the equator there is the monsoon, and on its western boundary the southerly and S.W. currents which have been referred to. Now the great proportion of the hurricanes traced by Mr. Redfield and Colonel Reid were first discovered between it and the westerly monsoon, and afterwards advanced along the American coast till beyond the tract of the trade-winds, where they were supposed to drift along with the westerly winds. In fact, they seem to have moved from the equatorial border of the N.E. trade-wind round its S.W. and western limits to the opposite side; and these very confines which define the trade-wind is a direct proof of the existence and proximity of contrary currents. As many local and unknown causes may favour a more or less powerful development of the westerly winds on the surface of North America, so will the tracks of revolving storms be more or less to the westward. The subject is merely adverted to in general terms, as affording a close analogy between the state of the winds connected with West India and Mauritius storms, and as presenting a very interesting field for inquiry.

The typhoons in the China seas are evidently revolving gales, and appear to be common at the change of the monsoons, more particularly at the commencement of the N.E. monsoon, which they seem to usher in, and it would be easy to show that they are found lying between, and connected with the advancing and retiring currents. As it does not always follow that the setting in of these winds is attended by violent gales, it may be inferred that certain local causes are necessary to establish a complete rotation of their margins. The course of these terrific storms seems to be along the coast of China, impinging on the land, near which they blow from E.N.E. to N.E., while, on the west coast of Luconia, they usually veer from N.W. to west and S.W., "with heavy rain and a cross turbulent sea."* They generally prevail with greatest violence in the northern part of the China seas, and as they are most common and severe in the months of September and October, it would seem that they are at the equatorial edge of the N.E. monsoon.†

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* American Journal of Science for October, 1843.

In the Bay of Bengal, and on the opposite coast of India, storms of the same nature, and in all probability connected with the borders of the two periodical winds peculiar to that region during their changes, are well known to prevail and have the wind veering round the compass. But we are informed that Mr. Piddington has made them an object of inquiry, though hitherto we have not been fortunate enough to have met with the results of his observation, in this highly interesting field.

It is ascertained that when the sun is over the South Pacific Ocean a westerly monsoon blows even as far eastward as Tahiti, and extends from the equator to that island, and prevails in December, January, and February, during which the sky is dark and lowering, rain falls in torrents, and the weather is very unsettled. Between this and the S.E. trade-wind hurricanes would appear to travel in the same direction as those which pass Mauritius. The annual indications of passing tempests which reach the Harvey group of islands, and "strong currents of air resembling whirlwinds which occasionally sweep across the islands (Society group), and produce considerable devastation among the plantations and habitations of the people,"* are attributable to the same causes. Mr. Williams remarks, that at the Island of Rarotonga, in lat. 21° 20′, long. 160° W.—

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* Horsburgh, page 203.

† Horsburgh, 201, Notes.

> "Mostly once, or frequently twice, in the year a very heavy sea rolls over the reef, and bursts with great violence upon the shore. But the most remarkable feature in the periodically high sea is, that it *invariably* comes from west and S.W., which is the *opposite* direction to that from which the trade-wind blows. The eastern sides of the islands (Harvey's group) are, I believe, never injured by these periodical inundations."†

These observations lead us to infer that the storms passed to the north-westward of the island, and the swell is an unmistakeable sign of the violence of the monsoon in one direction, while the S.E. trade was blowing at Rarotonga from the opposite quarter.

It also appears that the hurricanes sometimes reach the Harvey Islands, and that which is mentioned by Mr. Williams as having passed over Rarotonga in December, is so exactly similar to those which visit Mauritius in the same latitude south of the equator, but a hundred and forty degrees more to the westward, that it merits particular notice.

On the 21st December a very heavy sea was rolling into the harbour of Avarua, in Rarotonga, and Mr. Williams

> "Was alarmed and distressed at the threatening appearance of the atmosphere, and the agitated state of the ocean." * * Next day "was one of gloom and distress. The wind blew most furiously, and *the rain descended in torrents from morning until night.* Towards evening the storm increased; trees were rent and houses began to fall. * * The night was terrifically dark and dismal, and the rain pouring down like a deluge."

A very graphic description of the hurricane is added, and it appears that it continued all the 23rd, when

> "The roaring sea, the pelting rain, the howling wind, the falling

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* Ellis's Polynesia.

† A Narrative of Missionary Enterprises in the South Sea Islands, by the Rev. John Williams, of the London Missionary Society.

trees, and infuriated appearance of the atmosphere, presented a spectacle the most sublime and terrible. * * The rain was still descending in deluging torrents; the *angry lightning was darting its fiery streams among the dense black clouds* which shrouded us in their gloom; the thunder, deep and loud, rolled and pealed through the heavens, and the whole island trembled to its very centre, as the infuriated billows burst upon its shores."

It is stated that soon afterwards

"*The wind shifted suddenly a few points to the west*, which was a signal to the sea to cease its ravages and retire within its wonted limits; the storm was hushed; the lowering clouds began to disperse."

The ravages committed by the tempest were quite commensurate with the account which is given. A vessel belonging to the Missionaries was

"Carried over a swamp, and lodged amongst a grove of large chestnut trees, several hundred yards inland, and yet appeared to have sustained no injury whatever."*

From this it appears that the hurricane began on the 21st and ended on the 23rd December, indicating its slow progress when near the tropic, and was accompanied by the same enormous and continued precipitation of water, during forty-eight hours, which takes place at Mauritius. It is also curious that there is no mention of lightning or thunder having been noticed during the first two days, and it is only towards the last half of the storm, when the wind was shifting to *west*, that these phenomena occurred. At one place it is stated that the "*east* end" of the chapel was blown in, and in another that "the gale veered gradually round the island." Although the S.E. trade is the prevailing wind at Rarotonga, it appears that the westerly monsoon occasionally extends as far south as lat. 20° in its neighbourhood, as Mr. Williams, when going from Aitu, in lat. 20° S., long. 158° 15′ W., to this island, and the course S.W. by W., "was baffled and perplexed for several days by contrary winds;" and on another occasion he went from Savage Island to Rarotonga, and from thence to Tahiti, a distance of "seventeen or eighteen hundred miles to the *eastward*," in the space of fifteen days, carrying a fair wind the whole time; but this was so unusual, that he calls it an "instance perhaps unparalleled in the history of tropical navigation." The prevalence of westerly winds, for a few days seems, however, to be not uncommon among the islands of the Pacific in lat. 20° S.

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* Narrative of Missionary Enterprises, &c.

Around our globe, for ten or twelve degrees on both sides of the equator, by means of the calorific influence of the sun, a new and periodical current of air is annually set in motion, and sweeps the surface of the earth in a direction exactly the reverse of that of the trade-wind.* It is already partly known, and will in all probability be hereafter more fully ascertained, that all the great hurricanes of both tropics originate at the adjacent confines of those aërial currents. But it would seem that other agencies, arising out of the irregular distribution of land and sea, are necessary, or at least conducive to their formation, but cease to have any marked influence on their career after being fully developed.

Beyond the tropics, the same causes of revolving gales may be supposed to exist in the tract of variable winds lying at the outer border of the trade; and near the coasts of great continents. But as the winds cease to be regular in the temperate regions, so we must expect that the circular motions of the aërial currents, if not less extensive and perhaps sometimes equally terrific in force as those of the tropics, yet they cannot be supposed to be so uniform or permanent in their action, or determined in their line of progression, as when moving between two regular currents. On the Atlantic coasts of Europe, westerly winds blow one portion of the year, and easterly the other; and although the former predominate, yet the latter prevail with great strength and continuance at times; and as they depend on the change of season, storms are known to be most common and violent about the period of the year when the one declines or yields to the encroaching force of the other. Indeed, from the Straits of Gibraltar to Cape North, the coast is famous for gales which often veer round the compass. Even our strong westerly gales, which blow for weeks without much change, must be considered as part of an immense circle of which the greater part is beyond the limit of our observation, and perhaps may be connected with the trades, and form one of those vast circuits to which Mr. Redfield refers all our winds.

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* For instance, in the southern hemisphere the Line westerly monsoon prevails, during the hot months, from the west coast of South America to the east coast of Africa, and the whole of this tract is liable to hurricanes at the period in question. At or near Tahiti H.M.S. the *Favourite* encountered a severe one, with all the signs of rotatory action. The Rarotonga storm occurred farther west. The Honourable Captain Grey, Governor of South Australia, during his travels on the west coast of New Holland, was exposed to a similar tempest at Dorre Island at the mouth of Shark's Bay; and still further west, the Mauritius gales and those of the Mozambique Channel are met with in the same latitude.

The same principles which have been assigned as the cause of great whirlwinds will also be found in a minor degree near high land, off capes and headlands, and in narrow straits, where the atmospheric currents are diverted into numerous new and conflicting directions. Hence in such situations, small, sudden, and often severe squalls, or smaller whirlwinds, are encountered, capable of dismasting a ship. But of course the motions of such masses of air are very eccentric and of brief duration. Although the violent collision of two winds must generally tend to produce circular motion at their junction, yet it is equally probable, from the laws of hydro-dynamics, that even one stratum of air moving, either directly or obliquely, towards an inert mass, will tend to run into gyration: and this may be equally expected where the former is parallel to the latter, especially where there is much disparity in their temperature, humidity, &c.

In June, 1843, when coming round the Cape of Good Hope,* and about forty miles distant from the coast, near the Keiskamma River, we encountered a very unsettled state of weather. The wind was N.W. off the land, and had been so for some days, and from time to time brought with it heavy dark masses of cumulo-stratus clouds, sweeping along the surface of the sea; preceded by severe squalls, accompanied by lightning and thunder, and discharging torrents of rain. As these brief but fierce storms passed us to S.E. the wind gradually veered by S.W. to S.S.E., and after lasting about an hour or so, died away and was replaced by the N.W. wind. In the first half of these miniature tempests the air felt hot and muggy, but as they began to subside the thermometer fell ten or twelve degrees. For twenty-four hours a continued succession of these took place, and during the night the display of electricity was truly terrific, for half an hour at a time the masts seemed to be completely enveloped in lurid flame, and forked lightning was seen darting from the leaden-coloured cloud into the mast-heads; so continuous and flickering was the glare, that several persons imagined the vessel was on fire. On two occasions the decks were covered with hailstones of an immense size, which fell at the moment when the thunder was deafening, and the electric fluid was evolved in an intense degree, and the storm had lulled to dead calm, while a heavy jumble of a sea was knocking the vessel about. In the last of these "Cape squalls" the wind went round from N.W. to S.S.E. so suddenly, that the ship's head could hardly be paid off to prevent the topsails being taken aback, and it ushered in a tremendous gale from S.E., which blew for twelve hours with such fury, that although the ship was driving dead on a lee shore she could only carry a close-reefed main-topsail, and was left within eight miles of the coast when it abated.

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* As a passenger on board the *Katherine Stewart Forbes.*

That we were on the confines of two winds on this occasion is sufficiently obvious, and that the sudden storms were vortical masses between the two, seems to be equally probable. Unfortunately, the ship's barometer was broken, and an opportunity was lost for observing its oscillations on these occasions.

A somewhat similar case occurred in the opposite hemisphere. When coming down the Mediterranean, in a schooner called the *Concord,* we carried a strong S.E. gale with us from Sicily till abreast of Sardinia, when, on the 3rd September, 1833, "it blew in violent squalls, with heavy lowering clouds coming up on the wind, and towards evening the lower clouds were seen flying overhead to N.W. at a prodigious rate, while over these another stratum was drifting in an opposite direction. About sunset we were suddenly enveloped by a canopy of black and awful looking clouds, and the thunder pealed as if many hundred pieces of artillery had been discharged at once, when, all of a sudden, from blowing a hurricane it fell calm. The sea was running mountains high, our vessel, under bare poles, tumbled about in a manner that caused great apprehension lest something serious should happen, as she was quite unmanageable, and lying at the mercy of the breakers around us. In this state, a water-spout was suddenly formed (discovered) on our larboard quarter, while the schooner was helpless, and without a breath of wind to move away from this new danger. The dark cloud over head was fast drawing up the water in a vapoury stream, as if from a boiling caldron. Providentially this fearful phenomenon passed obliquely by our quarter, within 80 or 100 yards of the vessel. Soon afterwards a N.W. gale set in, in gusts and squalls, right in our teeth, and our decks were swept by the crests of the old sea being blown on board, while the schooner was dancing on the tops of the waves, or plunging into the hollows between." The above note is quoted from a journal written at the moment, and still in our possession; but the scene left too vivid an impression to be easily forgotten. The calm between the S.E. and N.W. gales lasted about an hour, and as the latter wind set in, a bright line on the north-west horizon, showing the last rays of twilight, appeared, and the thick bank of clouds gradually rose in an arch from the same quarter, and was carried away to the S.E., and by midnight the stars were seen, although it still blew a heavy gale. At the time we had no idea of observing rotatory action in the waterspout, but it was so near that the misty communication between the cloud and the sea was evidently not even so dense as a heavy tropical shower of the same diameter. Judging by the trough of the sea in which the schooner was lying, this phenomenon appeared to travel towards the N.E. or E.N.E. With two winds blowing so near, it is scarcely assuming too much to suppose that, although it was calm at the level of the sea, the effect called a waterspout was the natural consequence of vortical action, caused by the conflict of the currents in the upper strata of the atmosphere.

SECTION XI.

TORNADOES; ON THE COAST OF BRAZIL, WEST COAST OF AFRICA, AND PROBABLE CONNEXION WITH TWO CURRENTS OF WIND.—THUNDER-STORMS; IN THE STRAITS OF MALACCA, NORTH AMERICA, SCOTLAND. — HAILSTORMS, AND THEIR VORTICAL ACTION. — WATER-SPOUTS AND WHIRLWINDS; AT HATFIELD, CANTON RIVER, COPENHAGEN, COAST OF BARBARY.—PROFESSOR ŒRSTED'S OPINION WITH REGARD TO THE NATURE OF WATER-SPOUTS.

TORNADOES.—It may be considered as too comprehensive a view to suppose that the various phenomena which belong to these heads are all of a vortical nature, nor would any one be able to maintain such a doctrine in our present state of knowledge, but it is not mere conjecture to assert that they do very frequently develope signs of rotatory action; and the only proofs of the contrary are altogether negative. From the records of storms of the nature to which we refer, an abundant supply of direct, and much indirect, evidence may easily be gleaned, for the purpose of demonstrating that they are almost invariably found at the junction of two currents blowing in different directions; and their resemblance to great hurricanes, not only in this respect but in other points, may be traced. The tornadoes of the coast of Africa, pamperos of South America and of Mexico, the brickfielders of Australia, and thunder-storms of every region of the globe, seem to be dependent on the causes which have been assigned. Being connected with limited and periodical changes of wind, often consequent on the transitions of the day and night on the coasts of the great continents, these terrible, though brief, tempests are at certain seasons of almost daily occurrence, generally speaking after the maximum heat of the land begins to subside.

On the coast of Brazil it appears that "thunder storms were experienced almost daily" by Mr. Caldcleugh, who, in mentioning the way that these storms commence observes:—

> "The sky was perfectly clear until about two or three o'clock, when some light white clouds were seen approximating the sun with great rapidity. Sometimes they all passed, but if one lingered, as if within its influence, thunder was heard, and in a few minutes no remains of a blue sky were visible. The storm commenced directly, and the change that took place in the temperature often caused a kind of *whirlwind*."*

It is hardly necessary to remark that the S.E. trade-wind, or sea-breeze, as it may be called, prevails on this coast, and that the thunder-storm alluded to came from the opposite direction. This is further confirmed by Lieut. Milne, R.N., who states that the pampero "blows from the pampas or plains of Buenos Ayres, and extends for many hundred miles along the coast of Brazil." We also quote the following valuable observations made by the same officer:—

> "In addition to these remarks, I may mention, that, on the coast of South America, the barometer is very sensible of any change in the state of the weather, particularly with regard to the pamperos. Its general height in fine weather is 30.10 varying very little from that point, but on the approach of the pampero, the mercury sinks to 29.70 and even as low as 29.35. Should the mercury become stationary between these intermediate points, it will most certainly blow from the S.W., which is the pampero wind, and, during the period I served in the River Plate, I never knew this instrument err. But the most remarkable phenomenon which it presents, is the rapi-

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* Daniell's Meteorology, p. 345.

dity with which it rises on the squall reaching the ship. I have often observed the mercury rise upwards of the tenth of an inch in five minutes after the gust had reached us."*

The west coast of Africa appears to be greatly exposed to tornadoes, or thunder-storms, at certain seasons. But while the pamperos are found to travel from west to east, the African storms move exactly in the opposite direction, both, however, obey a law which impels them from the land to the sea.

At Sierra Leone, in lat. 8° 29′ N., there are two seasons, the "dry" and the "rainy," the former extends from November to March, during which the harmattan wind prevails from the land; and the latter, says Boyle, "may be said to commence in April, in July to assume the greatest strength, and to subside in September," and is marked by westerly winds and heavy rains. The tornado seasons are also two, the first in March and April, at the setting in of the wet months, and the second in September and October, when the east wind begins to predominate. During the winter or harmattan season these storms do not occur, and at the height of the opposite season, when the wind is westerly, the rain falls with appalling violence, and "nothing can be conceived so terrific and so awful as the thunder and lightning;" they are unusual, and on many parts of the coast wholly unknown. At the Gambia, however, where the strength of the trade wind opposes greater resistance to the westerly breezes of the rainy months they are not uncommon. It would therefore seem that the tornadoes are neither peculiar to the dry harmattan, nor to the westerly winds, during which electricity is vehemently displayed and rain is abundant, but are developed at the period when, and in the tract where the conflicting force of both currents, during their periodical changes, may be supposed to arise.

On the Gold Coast, we are told by Boyle, that, in the months of January and February, there are occasional showers, particularly in the evening, attended by thunder and lightning, but not at all to be compared with the violence of the tornadoes of Sierra Leone. Yet 80 or 100 inches of rain annually fall at this part of the coast.*

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* The Edinburgh New Philosophical Journal, for October, 1830.

It is readily perceived in the meteorological observation made at Sierra Leone, by Boyle,† that tornadoes are attended by rapid vicissitudes of temperature and wind. In February, when the humid west winds begin to replace the harmattan, "the climate becomes variable and unsettled. Shifting winds with dull oppressive cloudy weather, and occasional rains, mists, and *terrific storms* are experienced; and these alterations continue to be of frequent occurrence until May, when the rains set in." Further on we learn from the same authority that the tornadoes "are experienced for several weeks when the wind is veering round from the northward and eastward to the S.W. or westward." Also that the approach of the dry season in September "is almost invariably announced by two or three tornadoes, which commonly succeed each other at intervals of from two to three days. When these tornadoes occur, the weather is generally close, sultry, and oppressive; and through their powerful influence it becomes clear, exhilarating, and comparatively healthy." The agreeable sensations produced on the animal feelings are attributed to the effects of these storms, but are much more likely to be produced by the change of wind which follows them.

At the Gambia, in lat. 13° 40′ N., where the rainy season is a month or six weeks later than at Sierra Leone, the tornadoes are proportionately later in appearing, but are equally assignable to the same causes. In support of this opinion, the following brief extracts from a journal kept by Staff Assistant-Surgeon Tonnere may be offered, in which it is very distinctly seen that opposite currents of air are prevailing contemporaneously with tornadoes.

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* A Medico-historical Account of Sierra Leone, by Boyle. † Ibid.

Extracts from a Meteorological Table kept at Bathurst, on the Gambia.

Date.	Thermometer.			Winds.			Remarks.
	6 A.M.	2 P.M.	10 P.M	6 A.M.	2 P.M.	10 P.M.	
1842.							
Sept. 5th	79°	83°	80°	N.W.	N.W.	N.W.	Cloudy.
„ 6th	79	83	81	S.E.	Calm.	Calm.	Tornado at 4 A.M.
„ 7th	79	81	81	East.	Calm.	S.	Light showers.
„ 8th	78	82	76	East.	S.W.	E.	A heavy tornado at 5 P.M., rain all night.
„ 9th	76	80	79	East.	S.W.	S.	Light showers all day.
„ 10th	77	80	77	S.	S.	S.	Do. do.
„ 11th	79	79	78	S.	W.	S.E.	A tornado and frequent showers.
„ 12th	78	80	78	N.W.	S.E.	S.	A tornado at 3 P.M.
„ 19th	77	82	79	N.W.	S.W.	S.E.	A tornado at 8 P.M.
„ 23rd	77	82	89	E.	N.W.	S.	A tornado at 2 A.M., another at 4 P.M.
„ 24th	76	78	77	S.W.	S.E.	S.W.	Heavy rain all day.
October 2nd	77	81	81	S.E.	N.W.	N.W.	A tornado at 3 A.M., another at 10 P.M.
„ 6th	78	82	79	W.	W.	N.W.	A heavy tornado at 5 P.M., with rain.
„ 7th	76	82	78	S.E.	N.W.	S.E.	A tornado at 9 P.M., cloudy all day.

Owing to the discrepancy which exists in the descriptions of these storms as given by observers, it is almost impossible to gather any precise idea of their nature, of the veering of the wind, or state of the barometer. Their general direction appears to be from east to west, their duration seldom exceeds half an hour, but now and then they last for three or four, or even twelve hours. Thunder and lightning are almost invariable concomitants, but not always so; and it is the same with regard to rain, for although this generally falls in perfect deluges, yet there are also "dry tornadoes," during which there is no precipitation of vapour. Personal observers say that they have noticed a rotatory action of the atmosphere during the tornado, and Horsburgh remarks, in speaking of the interval between the trade winds near the Cape de Verde Islands, that "sudden squalls often follow calms, and are sometimes accompanied by whirlwinds in their first efforts against the resisting atmosphere." But on shore, the houses are generally secured against their approach on one side only. A note in our possession, we believe from Mr. Purdy's work on the Navigation of the North Atlantic, agrees with Boyle's account of tornadoes, in regard to their first appearance as a small white cloud in the higher regions of the atmosphere which increases by degrees, and as it descends the air begins to *revolve*, and the leaves are carried round in circles. Mr. Tonnere, however, an eyewitness of many of these phenomena, only recollects one in which the whirling motion was very distinct, so much so that it produced a degree of dizziness in watching it, and at the same moment the wind was so violent as to oblige him to lie down on the ground.

The commencement of a tornado is often preceded by a mass of clouds of intense blackness being drawn over the sky, and wrapping the earth in gloomy obscurity. Mr. Tonnere informs us in a note, that

> "Tornadoes generally give warning of their approach an hour before-hand, by a dark arch rising from the verge of the horizon, and when it ascends to a certain height a dead calm takes place, and a low distant moaning sound is heard before the storm bursts forth in its fury."

In the vivid description of an African tornado, given by Boyle,[*] it is mentioned that

> "Its approach is first discernible by the appearance of a small, clear, silvery speck at a high altitude in the heavenly expanse, which increases and descends towards the horizon with a gradual and slow, but visible motion. In its descent it becomes circumscribed by a *dark ring*, which extends itself on every side, and as soon as the silvery cloud approaches the horizon, veils it in impenetrable gloom. At the moment, the elements seem to have ceased their functions, and the very functions of nature to be paralyzed, the atmosphere appears to be deprived of the spirit of vitality, and a sensation of approaching suffocation pervades and oppresses the physical system. The mind is wrapt in awe and suspense; but the latter is speedily relieved by the dark horizon being suddenly illumined by one broad blaze of electric fluid; peals of distant thunder then break upon the ear, and rapidly approach and increase in frequency and violence till the shocks become appalling. When the thunder is at its loudest, a tremendous gust of wind rushes with incredible, and often irresistible, violence from the darkened part of the horizon, not rarely in its course carrying away roofs of houses and chimney-tops, blowing down or uprooting trees, and laying the stiffest and largest ships on their beam-ends or sinking them, whether under weigh or at anchor, and to that succeeds a furious deluge of rain, which falls in one vast sheet rather than in drops, and concludes this terrible convulsion."

This would lead to the inference that a vortical motion of the atmosphere is primarily formed in the higher regions, and a "dark ring" extending itself on every side clearly demonstrates circular action, and the body of clouds consequent on such a process would, in moving across a country, first present the edge of the circle as "an arch" rising from the horizon.[†]

The following extracts throw so much light on the subject of tornadoes, that we cannot forbear quoting them.[‡]

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[*] A Medico-historical Account of Sierra Leone, by Boyle.

[†] In the 6th volume of the Philosophical Magazine, there is a drawing and account of a singular storm-cloud which was in violent agitation, had the appearance of "a mushroom," and was surrounded by a ring or halo of vapour; and was formed for some time before any discharges of electricity became visible.

[‡] The Edinburgh New Philosophical Journal, for October, 1830.

"While off Cape Coast Castle, we were for some time almost daily exposed to them. About nine or ten o'clock in the morning, heavy black clouds were to be seen accumulating over the mountains in the interior of the country, and then gradually advancing towards the sea-coast. As the clouds approach the ship, torrents of rain are observed to be gushing from them, accompanied with the most vivid flashes of forked lightning, which dart down in continued sheets into the water. As soon as the squall had left the shore I generally caused every stitch of canvass to be taken in, and sent the people below till the tornado passed away to leeward. It is a curious fact, that whenever the clouds approached about half a mile from the ship, the thunder and lightning uniformly ceased; the dense clouds passed over our masts silently and harmlessly; and when they were about half a mile to leeward, the same phenomena recommenced which were before observable. These phenomena generally continued for about half an hour longer in their progress out to sea, after which time the rain ceased, and the sky cleared up. To these circumstances I may add another curious fact, which was observed by us frequently, that when the lightning had discontinued darting down from the clouds into the sea, and the squall was beginning to dissipate, we distinctly perceived the electric matter to be rising upwards from the water."

Thunder-Storms.—Circumstances of a not very dissimilar nature appear to characterise thunder-storms in all parts of the world. In the Philosophical Transactions, there is an account of one of these phenomena given by Veicht, which he encountered in lat. 1° 56′ N., Malacca bearing N.E. He says,—

"There was a fresh breeze south to S.S.E., the weather being hot and sultry. When daylight was gone there was not a cloud in the sky. This serenity continued till about 2 A.M., when a black cloud appeared above the horizon in the west and W.N.W., and continued to rise very fast, and the flashes of lightning which proceeded from it succeeded each other very fast. In a quarter of an hour it covered almost half the hemisphere, and as it approached the wind from S.E., died quite away at last. Soon after the whole heavens were covered with clouds." It must be remarked that the wind reached the ship before the thunder. In half an hour after its appearance on the horizon, it was over the vessel, and discharging electricity with great vehemence. "The wind brought very heavy rain *before* the thunder came near the ship, and in proportion as the thunder approached the ship, the wind which came in violent gusts, at first gradually decreased and the rain was less heavy, and when the thunder surrounded the ship and broke upon her, it was almost dead calm. Next day t was fine and the wind returned to the S.E. quarter."

The course of this storm was directly opposite to that of those on the west coast of Africa, and in the paper from which this extract has been taken, it is remarked that at Bencoolen, on the south-west coast of Sumatra, south of the equator, " the thunder-storms and squalls usually come contrary to the regular monsoons which prevail on the coast." From other sources of information we know that tornadoes drift from the interior of the Island of Sumatra to the S.W. during the westerly monsoon. Now this is also in a contrary direction to the pamperos of Brazil, in the same hemisphere, and distinctly shows that such perturbed masses of atmosphere acquire their direction from local or periodical currents. But it must be equally obvious to every unprejudiced mind, that they can only be borne along in opposition to, and with force sufficient to arrest, the lower currents, by the influence of an adverse motion of the higher strata. This is still more manifest by another example in the opposite part of the globe. The storm to which we refer happened in New England.

"The morning of 10th July, at Cambridge, was fair and hot, the afternoon was cloudy. At 5, it began to rain and thundered once. At Leicester, 40 miles westward, about 5 o'clock, the sky looked strangely, clouds from the S.W. and N.W. seemed to rush swiftly together, and immediately on their meeting commenced a *circular motion*, presently after which a terrible noise was heard. The whirlwind passed along from S.W. to N.W." It appears to have proceeded along with destructive violence, tearing up trees, scattering fences, &c., and a house was almost instantaneously destroyed by it. " The timbers lay broken and twisted to pieces between N.N.E. and *east*, for seventy or eighty yards from the house, some on the ground, others sticking into it a foot and two feet deep in all directions. Part of one of the main-posts, about ten feet long, with part of one of the plats of nearly the same length, and a brace which held them together, were left sticking in the ground, nearly perpendicular, to a great depth, in a field *southerly* from the house, about eight rods distant."*

A thunder storm, or "eddy," seen at Whitelaw, resembled an inverted cone, its motion was slow and majestic from S.W. to N.E. "It began to whirl round with great rapidity, accompanied by a loud rattling noise." The weather was *calm*, and soft showers were falling. There was little rain at Whitelaw before or after the whirlwind; but in the adjacent country to the north and east "there was such a torrent of rain, and in some places of hail, as had not been observed in the memory of man."†

The gyratory motion of the atmosphere in thunder storms has been so often observed, as to create a supposition that it is, in some degree, a principle essential to their full development. In every case where due attention has been given to the subject, it has almost clearly been determined, that these phenomena are connected with, and generally take place between, two strata of atmosphere moving in directions more or less opposed to one another. But as the aërial currents prevailing during the season, and in the tracts frequented by tornadoes are comparatively limited in extent, variable in their direction, unequal in force, and almost dependent on diurnal changes of temperature, they are inadequate to produce vast, durable, or progressive storms like the hurricane formed by great and, for some months, regular winds. Yet even in these sudden and terrific commotions of a few hours' existence, it is impossible, on mature reflection, not to admit the presence of the same elementary forces and consequences in a modified degree. In hurricanes the supply of force which is converted into rotation is derived from two strata of winds blowing on the same level, hence the disc formed between them moves round on an axis very nearly perpendicular; but the thunder-storm is apparently developed in the upper regions of the atmosphere between currents at different elevations, the one overlying the other, hence they will have a tendency to revolve round an axis varying in all the degrees from a horizontal to a vertical position, and in all probability this inclination undergoes a change during the different stages of the same storm. Besides, near the coasts of the great continents the semi-annual or even daily alternations in the course of the atmospheric currents, will take place in such a manner that the encroaching stratum would either penetrate in a wedge-like form at the surface of the earth, beneath the antagonist wind, or by overlapping it, so that in either case their conterminous surfaces will be in a line more or less inclined from the vertical. Consequently the masses of atmosphere interposing between them, if in stormy agitation, will revolve in planes varying to every position.

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* Philosophical Transactions, vol. lii. page 515.

† Philosophical Magazine, vol. iv. p. 219.

In those overwhelming gusts of wind which sweep along the surface of the earth for a few minutes only, and are called "arched, descending, or white squalls," the current of air appears to proceed from a dark, cumulous cloud, which discharges rain either before or after the squalls. Such phenomena are inconsistent with any other explanation on the known laws of pneumatics, than that of a descent of air at one point and ascent at another, or rotation in a vertical plane. Although of no great extent or duration, a furious and instantaneous blast felt at the surface would otherwise be preceded by a horizontal movement of the lower stratum in front, and succeeded by a commensurate rush of atmosphere from behind, but the awful and almost portentous stillness which precedes and follows these commotions, proves that they are wholly unconnected with any horizontal motion of the adjacent masses on the level of the earth.

It is thus easy to conceive how, in some cases of tornadoes, complete and violent gyration may be developed at the level of the earth, while in others, where they rotate on a horizontal axis, the wind at the surface of the earth will only be felt blowing in one direction, as in "arched squalls" and other modifications of the tornado. Many circumstances may occur to cause disturbances at the level of junction between a higher and lower stratum of air, particularly the ascent of a heated mass through the latter, or of a cooler portion of the former sinking down below its proper level and mingling with the other. While the atmosphere at a great altitude is clear, there are no means of discovering even the most violent degree of motion, until the formation of visible vapour partially reveals to us what is going on, but also very quickly screens a further view of the process on which it depends. In the African tornadoes, Boyle and others say, that in a quarter of an hour the temperature falls from 86° to 74°, or even 69°. Now such a sudden and temporary degree of cold as this can only be explained by the rarefaction of air from vortical action, at a point of diminished pressure, as air falling from a height, by the consequent liberation of its own latent caloric, is supposed to reach the earth at the same temperature as the lower stratum.

Hailstorms.— In the thunder-storm accompanied by showers of hail, still more unequivocal signs of vortical action and opposite currents may be recognised. When at a great altitude in the atmosphere, where the temperature is very low and the proportion of vapour very small, the first stages of such a phenomenon would most likely elude all observation. But when the effects of circular and centrifugal action, by removing the air from the centre of the vortex, formed a natural cylinder, a rush of air would enter at the inferior extremity from the subjacent stratum, and during the changes consequent on its ascent, the vapour which it contained would rapidly be condensed and congealed, fall downwards, and perhaps be re-dissolved by the heat of the inferior layers of air, and be for a time suspended as heavy dark clouds till a continuance of the process reduced the whole to the temperature of condensation. Thus, we should first perceive on the otherwise serene sky that small cloud "no bigger than a man's hand,"—that "silvery speck" which so rapidly extends itself till its broad base of tempest-tost clouds rest on the earth, and veil from human observation its conical figure and apex, terminating in a vortex of transparent air. The confused motion seen at the lower surface of such clouds, before they descend to the level of the earth, has exactly that appearance which would result from an ascent of comparatively warm air and descent of half condensed vapour.

The enormous size of hailstones, their spherical or oblate form, and concentric layers, are almost conclusive with regard to their being formed by the rapid admission of air containing vapour into a locality of extreme cold. Hailstones of incredible size—we may safely say of many pounds' weight—have been known to fall during sudden storms. Now it is hardly possible to suppose that, in sinking downwards from the greatest height at which vapour exists in sufficient quantity to form their nuclei, such a vast accumulation of congealed matter could take place if their descent was unretarded. But, if we admit that they acquire their form and dimensions within the sphere of a vortex, and that their gravitation is opposed by the well-known but extraordinary force of the up-current proper to such phenomena, we can readily understand how, during their retention within the gyratory action of the focus, near the level of congelation, they attain the magnitude which authentic accounts record. The very narrow track which hail-storms follow across a country, very plainly shows how restricted the sphere of their action is. The evolution of electricity so generally attendant on them, is in all probability due to the conducting medium of the vortex, which connects different layers of the atmosphere, or to simple friction.

In the account of a hail-storm which occurred on the 28th July, 1835, in the mountains of Auvergne, Pay-dedame, by De la Rive, it appears[*] "that, two minutes after this whirlwind kind of motion, there was a fall of hailstones;" and further on, in speaking of the cloud, he observes, that "the edges revolved." "There were *two currents*, the one placed above the other, which crossed each other at right angles."

> At Hitchin (in Herefordshire), on the 4th May, 1697, about nine in the morning, it began to lighten and thunder extremely, with some great showers between. It continued till about two in the afternoon, when, on a sudden, a black cloud arose in the S.W., *the wind being east*, and blew hard; then fell a sharp shower, with some hailstones which measured seven or eight inches about. * * The hailstones fell in such quantities, and so great, that they tore up the ground, split great oaks and other trees in great numbers.

Although hail-storms generally occur in temperate countries, and during the height of summer, many instances might be adduced of their appearance within the tropics. Even at Mauritius, in lat. 20° S., it is recorded that a heavy fall of hail took place at Moka, only 800 or 1,000 feet above the level of the sea, in the month of Dec., 1799, when the mean temperature in the shade is 82° of Fahrenheit. Now, in this latitude the curve of perpetual congelation is never less than 14,000 feet above the earth, where the barometer would stand at about 15 inches, and the proportion of humidity must be almost imperceptible. The formation of hail at this level could only be effected either by vortical action in the frigid stratum sucking up the moist atmosphere from the under-lying masses, and freezing their vapour, or by a similar process in the layers near to, but below, the level of congelation, producing extreme cold by the rarefaction of air in the focus. The intensity of the cold and size of the hailstones must have been considerable, to allow of the latter falling from such an elevation through hot masses of air on the surface of the earth without being redissolved.

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[*] The Edinburgh New Philosophical Journal for July and October, 1836.

Waterspouts and Whirlwinds.—Another set of phenomena are so intimately associated with those which have been considered, as to merit some notice, more especially as we believe them to be almost identical with, and only differing from, hurricanes and tornadoes, owing to modifications of the same causes. The suction power of a vortex at a great elevation would act as we have just attempted to describe; but if the same phenomenon is established in the hot and humid layers of atmosphere near the earth, and the inferior extremity of the focus or syphon applied to the surface of the land or sea, the effects which belong to what are somewhat improperly called waterspouts — or more correctly speaking, whirlwinds—may be expected.

In the revolving discs of atmosphere, of many hundred miles in diameter, which constitute the tropical tempests, it is possible to demonstrate centrifugal force, and diminished pressure, even to the extent of two inches of the mercurial column; and that, in accordance with the fundamental law of hydrostatics in such a case, a rush of air towards this point takes place commensurate with the difference of pressure between the exterior and focus. But as the rotating mass rests on the earth, the aërial currents rush along its surface to the centre with that terrific force peculiar to the hurricane. Admit, by way of hypothesis, that two opposite currents meet, and are diverted into a vortical action in a horizontal plane at the elevation of 2,000 or 3,000 feet above the level of the sea, with a stratum of quiescent air interposing between the vortex and surface of the earth; and that by centrifugal action a temporary removal of the lateral pressure of the atmosphere takes place in the focus, at the same elevation, so that the barometer be at two inches below the ordinary standard proper to such a height, we may inquire what would be the consequence of such a state of things? It is natural to suppose that the air would be forced into this cylinder, not at the upper end, for this would be nearly physically impossible, unless the density of the stratum of air over-lying the centre of the rotating mass was greater than that at the lower extremity of the focal column; and we cannot conceive a case in which the diminished pressure exceeds the difference due to the geometrical progression between the upper and lower surfaces of the gyratory mass. But the air would rush upward from the under layer with a velocity as if impelled into a vacuum by a force equal to the depression of the mercury at the lower extremity of the vortex. Thus constituted, the suction power of the focus would operate with a force increasing from the circumference towards the centre, where it would extend downward to the greatest depth into the stratum of still air resting on the earth, and terminate in a point. In fact, from the visible condensation of vapour caused by the rarefaction of the air within the sphere of vortical influence, we have its very form and extent developed in that perfect outline, so expressively termed "*trombe*" by the French. The inverted cone of vapour, which seems to proceed from the base of the cloud, presents every indication of the commencement and extension downward of the suctive force; and when the phenomenon is on a grand scale, copious and continued deposition of rain takes place, in some cases inundating the narrow track which it pursues, and may perhaps be the source of some of those destructive floods which occasionally visit every quarter of the globe. But the updrawing power will extend in a modified degree lower than the point of condensation, and if near the earth or ocean, its influence will be perceptible below the cone of vapour. If the gyratory mass of atmosphere descend nearer the earth, and its vortical action be applied directly to its surface, the ordinary effects which distinguish the waterspout will be presented to our senses. Finally, supposing the whirling cloud which gives birth to this phenomenon were to sweep along the level of human habitation, in all probability it would leave behind a train of devastation, such as existing records have attributed to whirlwinds, thunder-storms, and hurricanes.

Now the waterspout,* which has already been noticed, occurred exactly under the circumstances which have been supposed. There were two violent winds blowing in opposition within a few miles of one another, most likely in a rotating manner, between which it was formed at a considerable elevation, while a calm prevailed on the surface of the ocean. In the *Exmouth* gale the waterspouts were connected with opposite currents, and it was equally so with those observed by the *Katharine Stewart Forbes* in that of Rodriguez. Colonel Reid mentions several cases of the same kind. In almost every account of a waterspout, it is admitted that they revolve, and only appear in cloudy weather, generally speaking, before or during stormy commotions of the atmosphere.

De la Pryme describes a waterspout at Hatfield, which happened on the 21st June, 1802:—

> "The day was pretty warm about two o'clock; *no wind stirring below,* though it was *somewhat great in the air,* the clouds began to be much agitated, and driven together; on which they became very black, and were visibly hurried round, from whence there proceeded a most audible whirling sound like that commonly heard in a mill. *After a while* a long tube or spout came down from the *centre* of the congregated clouds, in which was a swift *spiral motion* like that of a screw."†

Another of these phenomena was observed by the light-keeper at Corsewall, which proceeded from a mass of clouds formed on the Irish shore about noon, and gradually coasted along till opposite Cantire, to which it crossed, and then moved on to Arran. The "thick dark column, as if suspended from the darkest part of the cloud, was remarked to *revolve* from east to west, and the water immediately below was in terrible commotion, while all around was smooth."*

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* At page 263.

† Philosophical Transactions, vol. xxiii. No. 284.

It seems to be generally admitted that waterspouts revolve, and are identical with the whirlwinds on land. Horsburgh observes:—

> "When a whirlwind happens on land, all the light substances on the surface of the earth within its course, are carried up in a spiral motion by it. I have observed one pass over Canton river, in which the water ascended like a waterspout at sea, and some of the ships that were moored near its path, were suddenly *turned round* by its influence. After passing over the river, it was observed to strip many trees of their leaves, which, with the light covering of some houses or sheds, it carried up a considerable way into the atmosphere."†

It seems, however, to be still a very unsettled question whether waterspouts always rotate in one direction. Colonel Reid appears to think they do so, and in a direction contrary to that of the great hurricanes of the hempishere in which they occur, but offers no opinion on what known principle they should do so. Oërsted merely says they revolve, without arriving at any conclusion with regard to the direction. He remarks that "the circular rapidity of waterspouts is always very variable, for frequently the eye can hardly follow it, while at other times their motion is not so violent. Almost all observers expressly mention this circular movement, and I do not find that its existence is contradicted by any who have themselves seen the phenomenon;" and adds, "that the lower part of the waterspout has no circular movement so long as it does not touch the ground."

When the waterspout or tornado took place at Eu on the 16th June, the barometer, which had been stationary for two days, fell at 7 A.M. as much as 2½ lines; at 8 A.M., the waterspout made its appearance and passed by; and at noon, the mercury had regained its former level. On this occasion it was observed that some of the clouds "went in an opposite direction from the rest."

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* New Edinburgh Philosophical Journal for October, 1832.

† Horsburgh's East India Sailing Directions, p. 8.

On the occasion of another waterspout at Copenhagen, it was remarked by Hohn, "that through the openings in the lower strata of clouds, a rotatory movement in those lying above were observed;" and that "the clouds, after all appearances of a waterspout had ceased, nevertheless retained a *rotating movement.* It was at the same time remarked, that not only those clouds which formed the upper portion of the waterspout, but *all the rest at some distance possessed a circular movement.*"* Here at least is distinct evidence of extensive and perfect rotation of the whole mass of cloud in connexion with a waterspout. Was the air beyond the range of condensation also in rotation?

Oërsted considers their height to vary from 1,500 or 2,000 feet to 5,000 or 6,000,—that they move at the rate of thirty miles an hour at one time, and at another are stationary. Their progression is occasionally straight or zig-zag, and they move from S.W. to N.E. That they generally travel in this direction seems to be probable, and it corresponds with that followed by hail and thunder storms in the north of Europe; but it will be seen, by the following extracts, that even in the northern hemisphere they sometimes pursue an opposite course; and, in all probability, it will also be hereafter discovered that they rotate from east to west, as well by the north as by the south point.

In the "Philosophical Transactions,"† we find a paper by Mr. Stuart, giving an account of three waterspouts having been observed on the coast of Barbary, moving with a N.E. wind in a S.W. direction.

"It was hardly distinguishable," he says, "whether the sword-like spout fell first down from the cloud, or the pillar of water rose first from the sea; both appearing opposite to each other all of a sudden; only I observed of one of them, that the water boiled up from the sea to a great height, without the least appearance of a spout pointing to it either perpendicularly or obliquely, and here the water of the sea never came together in the form of a pillar, but rose up scatteredly, the sea boiling furiously around the place."

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* Edinburgh New Philosophical Journal, by Jameson, vol. xxvii.

† Vol. xxiii. page 1077.

This agitation of the surface of the water moved along with the wind to S.W. in the same direction as the more perfectly formed waterspouts, and seems to have been merely a minor degree of the same process. The different waterspouts repeatedly broke and reformed again in the same place. The oblique spouts pointed from the wind. The aqueous vapour ascending near the centres is said to have been "like smoke going up a chimney." The appearance of these phenomena had been preceded by thunder and lightning in the N.E., and followed by a "*half hour's violent storm;*" but there is no mention of any electrical appearance when the waterspouts were subsequently developed. The whole of the circumstances would lead to the inference that a higher S.W. current was prevailing while the lower wind was N.E.

Another case,* somewhat similar, is related as having happened in the Downs during the month of March, where a waterspout was formed at the lower part of a heavy black cloud. A "sparkling" of the water, at the surface of the sea, ran along to leeward, under the spout projecting from the cloud. The wind was E.N.E., and "two hours afterwards the heavens were entirely overcast," this was followed by much *hail,* and "both the wind and cold increased."

The *Tigris* steamboat, employed in the Euphrates expedition, seems to have been destroyed by a tornado or whirlwind. In the "Law of Storms," (p. 408) we find it stated that at the time of the accident, the wind was

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* Philosophical Transactions, No. 270.

E.N.E., "when a dense black cloud was observed moving across the wilderness from W.S.W., and in the teeth of the wind." It appears to have been drawing up sand about the centre, and precipitating it again with great force and rapidity. The barometer fell .20. It is not mentioned whether any change of wind took place, but it is obvious that this was a moving vortex, borne along by the higher current "in the teeth" of the lower, and in communication with both. Such, in all probability, are the pillars of sand that are frequently discovered moving across the great deserts, and that may also be the means of conveying from the shores of Africa, to Malta and Sicily, those extraordinary showers of fine sand which are deposited on these islands by S.W. winds.

The term waterspout is certainly not very appropriate to the several phenomena in question, as it conveys the idea of only one effect of too casual an occurrence, to be employed as its specific character, and it is still a subject of great doubt whether its existence has ever taken place to the extent implied,—that of raising a column of water from the sea, and afterwards letting it fall. The effect of the vortex, applied to the surface of water, appears to cause a rapid ascent of the vapour near the centre, which, at a certain height, is thrown towards the exterior of the revolving column, and falls in showers around the circumference. Every one who has been within a few hundred yards of a waterspout, will admit, that the column connecting the cloud with the sea consisted of vapour and rain. Many of those clouds, accompanied by sudden squalls, which occur in the neighbourhood of the Cape de Verd Islands, in moving along, pour out a torrent of rain at one narrow point, which, seen at a distance, looks like a dense column exactly resembling the waterspout. The water which proceeds from a waterspout is always fresh, nor are we aware of any case, even at sea, where it was otherwise,—and this is a very strong evidence of the rapid and continuous in-draw of air at the vortex to produce the deluges of rain poured out by such phenomena on land.

In the present day, the favourite cause for every obscure phenomenon, is sought for in the mysterious and wonderful arcana of electro-magnetic force; and of all those terrible commotions of our atmosphere, there is none to which this agency may be more plausibly applied as the primum mobile, than that of the waterspout or thunder storm. It is true, waterspouts are very commonly seen in connexion with great activity of atmospheric electricity, but it is not always so; many of these phenomena are well recorded, and no notice whatever taken of the equally impressive appearance of lightning or thunder. In countries where electricity is evolved with terrific vehemence and frequency, we do not hear of waterspouts being equally common, and especially near the west coast of Africa, where, in the tornado season, this element is developed with a degree of intensity that surpasses anything elsewhere experienced. Nor is the instantaneous action of electric force likely to be the cause of the comparatively equable and continuous process of a waterspout.

But the influence of vortical agency in one of the upper strata of the atmosphere, affords an intelligible explanation of all the visible effects in question, more particularly that of copious and prolonged condensation of vapour within the narrow and isolated locality of that dark black cloud, the base of which, in most cases, is all that man can detect of the operation going on above it. A sufficient number of cases have been given in which opposite currents and a revolving action, not only of the "spout" alone, but also of the whole body of cloud, have been distinctly made out, to lead us to infer that they are closely allied to the cause of the more ostensible phenomena.

In concluding this part of the subject, which has reached much beyond our original intention, we shall quote the opinions of one, whose high position in the scientific world will always secure them great consideration and respect, and whose brilliant discoveries in electro-magnetic science entitle his observations to no common attention; and in an especial manner point him out as pre-eminently qualified to pronounce on the influence which electricity and magnetism are likely to exercise on the formation, duration, and violence of waterspouts and other atmospheric commotions of a vortical nature.

On Waterspouts by Professor Oersted.*

Although we are certain that the formation of waterspouts is accompanied by electrical action, yet we are not, therefore, entitled to conclude that electricity is their cause. Distinguished naturalists have expressed this opinion, but without explaining the manifold peculiarities of the waterspouts. But still, even more recently, it has been attempted to explain by this cause their rotatory movement, by assuming in them the existence of a strong electrical current, which, by means of the magnetism of the earth, received its circular movement. It appears to me, however, that there is much to contradict this opinion. Although we possess the clearest proofs of the electrical nature of waterspouts, yet it seems to me not at all proved by any of the effects noticed, that they contain an electrical current. Individuals who have been in contact with waterspouts never felt an electrical shock, or should a shock actually have been experienced in any instance without our being aware of it, yet there have been many cases in which it was not the case, although the human body can neither enter nor quit an electrical current without receiving a shock. A decisive argument, in my opinion, which can be opposed to such a view, is, that a waterspout, whose electricity should be of such a description that the magnetism of the earth could communicate a stronger circular movement, must act very violently on the magnetic needle; now this has never been noticed in any one of the numerous vessels which have been in the vicinity of waterspouts. Even though it were to happen that *on one occasion* the needle should be affected by the approach of a waterspout, still this would by no means afford sufficient proof for such an electric current, as that assumed to exist by the theory must *always* throw the magnetic needle into considerable agitation. Hence it seems evident, to me, that the electricity of the waterspout, as well as that of the thunder storm, is not the cause but the effect of the natural phenomenon.

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* Edinburgh New Philosophical Journal, by Jameson, vol. xxvii.

In considering the waterspout, we have endeavoured to arrive at its proximate causes from the effects which have been observed and recorded; and we have ascertained that a whirlwind, which begins in the higher regions of the air, and becomes expanded as it descends, constitutes the essential element of the phenomenon. It will however be further asked,—What is the cause of this vortex? We perceive plainly that a whirlwind can be produced by two currents of air following parallel courses, but flowing in opposite directions. There is nothing to prevent us from assuming the existence of such currents in the higher regions of the atmosphere. They must often occur there while the air beneath is perfectly tranquil; at least, during an aërial voyage a whirling cloud was met with; but we must also admit that we are in possession of no evidence of such air-currents actually existing at the period when a whirlwind is formed.

Such are the opinions of Oërsted, and they seem to embody the theory of the greater proportion of those aërial disturbances, arising out of opposing currents, which must be expected while our atmosphere is subject to the conflicting action of the earth's rotation, the periodical and local changes produced by caloric, and the unceasing laws of gravitation tending to equilibrium. Hereafter, when the currents set in motion by these forces shall be more carefully investigated, and traced to their respective sources, it may be ascertained, that the mechanical effects resultant on their collision are capable of developing those sublime and mysterious phenomena which leave so profound an impression on the mind, as to lead some to doubt whether the puny experiments of man, in raising vapour by heat and condensing it by cold, or inducing electricity by friction, or a rush of steam through a narrow orifice, can be miniature representations of the same elementary action which nature displays on so grand a scale.

SECTION XI.

EXTRACTS FROM THE LOG-BOOKS OF THE SHIPS WHICH ENCOUNTERED THE RODRIGUEZ HURRICANE OF APRIL, 1843.

The following extracts were copied from the log-books of the respective ships, at the office of the captain of the port at Port Louis, but in most cases they were afterwards taken on board of the vessels, where omissions were filled up and errors corrected by the officers.

No. 1 on the Diagrams.

Extracts from the Log of the ship Margaret.

March 27th, 1843, squally and fresh breezes, a heavy sea and a good deal of lightning, wind N.W.; lat. 9° S., long. 73° 41′ E.

On the 28th, the wind variable and light; lat. 9° 37′ S., long. 72° 37′ E.

On the 29th, wind S. by E., squally, heavy rain and "dark threatening appearance;" lat. 10° 46′, long. 70° 23′ E.

On the 30th, light variable wind; lat. 11° 29′, long. 68° 15′.

April 1st, wind south to S.W., cloudy and heavy rain. The weather squally and a heavy head (S.E.) sea running. Lat. 13° 2′, long. 65° 30′.

On the 2nd, the wind south, veering to W.S.W. "Threatening looking weather," squally, ship pitching heavily and shipping seas, vivid lightning, lat. 14° 32′, long. 65° 56′ E.

On the 3rd April, wind at 1 p.m. west, light breeze at first; at 12 p.m. W.N.W., squally and wind increasing; at 8 a.m. N.W., stormy, dark and lowering, rain and lightning from westward, lat. 16° 38′, long. 65° 30′.

Hours	Courses.	K.	F.	Wind.	Remarks.
					4th April, 1843.
2	SW.byS.	9		NWbyW	These twenty-four hours commencing with fresh gales and constant rain. The ship rolling and labouring heavily. At 4 p.m. sent down the topgallant-yards. At 8h. the ship labouring and straining much; reefed the foresail and topsail.
4		10			
6		10			
8		10	4		
10		10	4		
12		10			

Extracts from the Log of the ship MARGARET (*continued*).

Hours	Courses.	K.	F.	Wind.	Remarks.
					4th April (*continued*).
2	SW.byS.	10		NWbyW	At midnight, do. gales and heavy rain.
4		10			4h. A.M. do. weather.
6		10			At noon, strong gales and heavy rain;
8		10	4		the ship rolling and pitching heavy,
10		10	4	Variable	the people attending the pumps.
12		10	4	Do.	(Running but blowing strong gales of
				N.N.E.	wind.)
					The sun obscured.
					Lat. 19° 54′ S., long. 64° 22′ E.
					5th April.
2	S.W.	9	4	N.E.	These twenty-four hours, commencing
4		9	4		with strong gales and a heavy cross
6		10			sea, the ship labouring and straining
8					very much. At 8 P.M., the gale increasing,
10					and the sea getting very
12					high, handed the fore-topsail and
					foresail, and hove the ship to under
2					close-reefed main-topsail. At 10h.
4					30m. P.M., a heavy sea broke on
6					board and carried away the troops'
8					cook-house and coppers, the larboard
10					lower studding sail-boom, and a
12					quantity of the ship's stores. At
					midnight, strong gales and heavy
					rain attended with thunder and lightning,
					the ship making much water
					through the decks and top-sides. At
					noon, ditto gales, the people attending
					the pumps, the ship's head up to
					N.N.W., and off to N.W.—More
					severe, hove the ship to at dark, sea
					running high.
					Sun obscure.
					Lat. 21° 32′ S., long. 63° 15′ E.
					6th April.
2	Up to				These twenty-four hours, commencing
4	N.N.W.			N.E.	with strong gales and hard squalls
6	Off to				of wind and rain. At 5 P.M., the
8	N.W.				ship, when pitching heavy, was
10					struck by a heavy sea which carried
12					away the jib-boom and bowsprit-shrouds;
					the wreck was obliged to
2					be cut away with the loss of the jib

Extracts from the Log of the ship MARGARET (*continued*).

Hours	Courses.	K.	F.	Wind.	Remarks.
					6th April (*continued*). and flying-jib for the safety of the bowsprit. At 10 P.M., the gale increasing, and the sea very cross and breaking heavy on board; carried away the coops and live stock. At midnight, ditto gales. At 8 A.M., more moderate, made sail, set the topsail and foresail, and let a reef out of the main-topsail. At noon, strong gales and heavy rain, the ship rolling heavy and making water, the pumps well attended to. Sun obscure. Hurricane heavy still. Lat. 22° 8′ S., long. 62° 52′ E.
4					
6					
8					
10	S.W.	9	4	N.E.	
12		9	4		
					7th April.
2	SW.by S.	9	4	NE.by N	These twenty-four hours, commencing with strong gales and a heavy cross sea, the ship rolling and straining much. At 4 P.M., the gale increasing, close-reefed the topsails and reefed the foresail. At 9 P.M., the trusses of the fore-yard broke, hauled up the foresail and hove the ship to, the fore-topsail having been blown to pieces at the same time. At 10 P.M., the gale increasing to a hurricane. At midnight, the main-topsail was blown from the yard and the mainsail from the gaskets when furled, set the spanker, close reefed. At 2 A.M. the spanker was blown to pieces, the sea breaking on board and the ship labouring and straining and making much water, the pumps constantly going. At 2h. 32m. A.M., a heavy sea broke on board and carried away the long-boat and pinnace from their choks and stove them to pieces, at the same time carrying away and drowning all the live stock, say, sheep, pigs, and poultry, also carrying away the ship's cooking-houses and coppers, a number of water casks and buckets. At 4 A.M., bent a new storm-staysail to the mizen-mast. At 5 A.M., the ship was struck by a heavy sea on the quarter, which carried away the rudder, broke a plank in the counter and the head of the stern post, carried away the round-house and a quantity of paints and oil, at the same time started her cargo, ship's stores, and a tier of water-casks in the hold. Found it necessary, for the safety of the ship and masts, to cut away the fore and main yard, which were broken from their trusses, together with the studding-sail, booms, and gear belonging
4		10	4		
6		10	4		
8		10	4		
9	Hove-to.				
10	N.N.W.				
12	to N. W.			Variable	
2					
4					
6					
8					
10					
12				S.S.W.	

Extracts from the Log of the ship MARGARET (*continued*).

Remarks on 7th April (*continued*).

thereto; both pumps, with much exertion, enabled us to keep the ship clear. At noon, hurricane strong from the S.S.W. with heavy rain and lightning, the ship labouring and straining very much, and carrying away the lower rigging and brace back-stays, and opening her water ways, both pumps constantly going.

Hurricane more violent when the wind shifted to the S.S.W.

Lat. 22° 19′ S., long. 60° 20′ E.

Hours	Courses.	K.	F.	Wind.	Remarks.
2 4 6 8 10 12 2 4 6 8 10 12	W.N.W. to N.W. by N.			S.W. SW byW	8th April. These twenty-four hours, commencing with strong hurricane and heavy squalls of wind and rain, attended with thunder and lightning, the people constantly at the pumps. At 6 P.M., ditto weather. At midnight, the sea breaking very high over all. At 2 A.M., the quarter boat and davits were carried away by a heavy sea, and part of the bulwarks. At 8 A.M., the hurricane not so violent. The carpenter, with all assistance, making the necessary preparations for the construction of a new jury rudder. At noon, ditto weather, with hard squalls of wind and rain, hurricane still violent, the ship's head up to N.N.W., and off to N.W. by N. Sun obscure. Lat. 22° 8′ S. long. 60° 30′ E.
2 4 6 8 10 12 2 4 6 8	W. by N. N.W.			SW. by S.	9th April. These twenty-four hours, commencing with strong gales and hard squalls of wind and rain, the sea running very high, the ship straining and making much water, the people clearing away the wreck and pumping ship. At 4 P.M., bent a new spanker, and set it close-reefed. At 8 P.M., sudden gusts of wind. At midnight, still squally and sudden gusts of wind. At 8 A.M., more moderate, the people sending down the topsail-yards and fitting them for lower yards. At noon, squally

Extracts from the Log of the ship MARGARET (*continued*).

Hours	Courses.	K.	F.	Wind.	Remarks.
10 12					9th April (*continued*). weather and a heavy sea, the pumps kept constantly going, the carpenter at the rudder, weather moderate but little. Lat. ob. 21° 19′ S., long. 61° 10′.
2 4 6 8 10 12 2 4 6 8 10 12	NWbyN to N.N.W.			W.S.W.	10th April. These twenty-four hours, commencing with squally weather and high sea. At 8 P.M., ditto weather and squally. At midnight, blowing fresh and the ship rolling much and making water. At 8 A.M., more moderate, the carpenters making a jury rudder. At noon, fair weather and a high sea, the pumps well attended to, people employed rigging the ship. The ship still without a rudder. Lat. ob. 21° 5′ S., long. per chr. 60° 30′ E.
	N.E.			N.W.	11th April. Fair weather, a heavy swell, rudder not yet ready. Lat. 21° 21′, long. 60° 43′ chr.
	N.W.			S.E.	12th April. Light wind, rigging jury rudder.

No. 2 ON THE DIAGRAMS.

Extracts from the Log of the barque ROBIN GRAY.

On the 26th March, 1843, wind S.S.E., steering S.W., 8 miles an hour, showery, fresh breezes, and squally, lat. 8° 40′ S., long. 79° 30′ E.

On the 27th, wind S.E., strong breezes, a heavy *head sea* (S.W.), carrying studding sails, course S.W., 8 miles per hour, lat. 10° 30′ S., long. 77° 30′ E.

On the 28th, the wind S. by E. but squally, and the top-gallant sails stowed, a turbulent sea, lat. 12° 10′ S., long. 75° E.

On the 29th, wind S. by E., strong breezes and cloudy, with a heavy swell from south, course W.S.W., lat. 13° 20′ long. 73° E.

On the 30th, wind *south*, course W. by S., 6 miles per hour, strong breezes and a heavy swell, lat. 14°, long. 70°.

Extracts from the Log of the barque Robin Gray (*continued*).

On the 31st March, fresh breezes and clear, wind S. by W. to S.W. by S., top-gallant sails set, course W. by N., lat. 14° 25′, long. 68° E.

April 1st, 6 p. m., wind S.W., fore part fresh breezes with a great swell from S.E.; 4 a. m., wind S.W. by W., latter part strong breezes, squally, with heavy rain; midnight, double-reefed topsails; noon, blowing strong, close-reefed topsails, lat. 14° 30′, long. 67° 20′.

On the 2nd, 4 p. m., wind S.W., blowing hard, with heavy squalls and "torrents of rain," the sea high and cross; 8 a. m., wind W. by N., vessel labouring heavily and shipping a great deal of water, lat. 15° 45′, long. 67° 20′.

On the 3rd, wind north, scudding, heavy rain, squally, and a high cross sea; at noon, the wind N.N.E., under reefed foresail and close-reefed top-sails, course S. by W., 7 miles per hour, lat. 18° 20′, long. 65° 30′.

Extracts in full.

Hours	K.	F.	Courses.	Wind.	Remarks.
					4th April.
4	8		SW.byW	N.E.	Scudding all day, blowing a strong gale, with showers and squalls, and the sea running very high all the twenty-four hours, down royal yards. Midnight, close-reefed the main and stowed the fore-topsail. At 8 a. m., set the close-reefed fore-topsail. Noon, cloudy weather and blowing hard, double-reefed the mizen, stowed the jib, &c. Sun obscure. Lat. 20° 30′ S., long. 63° 20′ E., by account.
8	8				
12	8				
4	8				
8	8				
12	8				
					5th April.
2	9		SW.byW	N.E.	Scudding, strong gales with cloudy rainy weather and a very high sea. 4 p. m., reefed the foresail. 10 p. m., the wind increasing, with severe squalls, stowed the fore-topsail. Midnight, stowed the foresail, the gale still increasing with dark rainy weather. 4 a. m., the wind and sea increasing fast; about noon, blowing to an awful extent, made an at-
4	9				
6	9				
8	9				
10	9				
12	9			East.	
2	9				
4	9				
6	9				

Extracts from the Log of the barque Robin Gray (*continued*).

Hours	K.	F.	Courses.	Wind.	Remarks.
8	9		N.W.	S.E.	5th April (*continued*). tempt to take in the main-topsail when it blew to atoms, running about 8 or 10 knots without a sail set. The sea making a breach at times over the vessel, a deal of the bulwarks carried away, and one of the guns overboard, long-boat full of water and the stock drowned, the pumps carefully attended. Sun obscure. Lat. 21° 30′ S., long. 60° 45′ E.
10	9				
12	9				
2	9		N.W.	S.E.	6th April. Scudding. 4 p.m., the wind veering round to the southward and blowing still the same. About 6, round to S.W., lulled a little for a short time. The sky looked rather finer, when, presently, it assumed a wilder aspect than ever, and blew a hurricane, always keeping right before the wind, and it still veering round towards the westward. At 8 p.m., the weather the same, the wind veering round to the N.W.W. Midnight, very squally with a deal of lightning and heavy showers, the wind veering round to the northward, running right before it. 2 a.m., the vessel broached-to and the helm lost all power over her, the wind about N.E., and her head to the N.W., blowing still and awfully dark, the ship almost on her beam-ends and the sea flying right over her. 4 a.m., wind and weather the same. At daylight, more moderate, with a very high sea, found our bulwarks and other things very much damaged. Noon, more moderate and raining heavy, the pumps carefully attended. Lat. 22° 02′ S., long. 61° 50′ E.
4	9		Before the wind.	”	
6	9		”	S.W.	
8	9		”	West	
10	8		”	N.W.	
12	8		”	North	
2	8		”	N.E.	
4			Lay-to.		
6			N.W.		
8					
10					
12					

The wind was most severe on the night of the 6th, but the sea was most heavy and the lightning more terrific on the night of the 7th.

Extracts from the Log of the barque ROBIN GRAY (*continued*).

Hours.	K.	F.	Courses.	Wind.	Remarks.
2 4 6 8 10 12 2 4 6 8 10 12				N E.	7th April. Cloudy rainy weather with a very cross sea. 4 P. M., the ship's head round to the southward, the double-reefed mizen, fore-spencer, and reefed foresail set. 8 P. M., the wind increasing and the night looking bad, stowed the foresail. About 10 P. M., blowing strong with a very high turbulent sea, the ship labouring very heavily and making a deal of water, all hands at the pumps. Midnight, dark and blowing hard, awful sea with a deal of thunder and lightning, the fore-spencer blown to pieces and the mizen split. About 2 A. M., the tiller chains broke, got them secured again, the pumps still gaining on us, all possible exertion used. Daylight, wore ship, in hopes that she would make less water in the other tack, some hands at the pumps, others driving oakum in about the stancheons, from four to five feet of water in her. About 10 or 11 A. M., got it to 18 inches. Noon, pumped dry as possible, blowing heavy with rain at times, the sprit, sail-yard, jib-boom, guy's back ropes, lower booms, and most of the gear about the bows cut, broken, and washed away, with a great deal of our rigging and gear aloft, cut and useless. The master protests against all damages the ship and cargo have sustained by the said gales.
2 4 6 8 10 12					8th April. First part of the day, strong gales with rain, latter part more moderate. At daylight, set the foresail and fore-topsail, and afterwards bent the main-spencer for a storm trysail, the mizen-boom broken, bent an-

Extracts from the Log of the barque ROBIN GRAY (*continued*).

Hours	K.	F.	Courses.	Wind.	Remarks.
2					8th April (*continued*). other main-topsail, clearing up the wreck, and bore up for Port Louis for the safety of the ship and cargo. Lat. at noon, ob. 22° 45′ S., long. ch. 61° 00′ E.
4					
6					
8					
10					
12					

April 9th, wind N.W., squally with showers but moderate, lat. 22°, long. 60° 30′.

April 10th, wind N.W. to north, light winds and latterly calm fine weather. At noon, saw the *Waverley*, lat. 21° 30′, long. 60° 12′.

NO. 3 ON THE DIAGRAMS.

Extracts from the Log of the brig ARGO *from Sourbaya to Mauritius.*

March 30th, 1843, wind S.S.E., course west, strong breezes, a heavy swell from the southward, lat. 18° 6′, long. 74° 10′.

On the 31st, lat. 17° 51′, long. 71° 48′, wind from south to east, E.S.E. Under reefed topsails.

April 1st, lat. 18°, long. 69°, same wind, two reefs in the top-sails.

On the 2nd, wind E.S.E. and S.E., strong gales, hard squalls, a heavy southerly sea, under double-reefed topsails, lat. 18° 17′ S., long. 66° 16′. At noon, close-reefed topsails.

Hours	K.	F.	Courses.	Wind.	Remarks.
2	7		W. by S.		3rd April. P.M., strong gales and hard squalls with a very heavy sea. At 8, furled fore-topsail. At 11, furled main-topsail. Midnight, heavy gales with rain and a very heavy sea constantly breaking on board, ship making much water. A.M., ditto weather. At 8, sent down the royal yards, housed the mast, &c. Noon, more moderate, pump constantly going. Lat. 18° 52′, long. 64° 33′.
4	7				
6	7			E.S.E.	
8	7				
10	7				
12	7				
2	7				
4	7				
6	7				
8	7				
10	7			S.E.	
12	7				

Extracts from the Log of the brig ARGO *(continued).*

Hours	K.	F.	Courses.	Wind.	Remarks.
					4th April.
2	5		West.	S.E.	P. M., moderate and a very hard rain at times. At 2, set topsails, double-reefed, rove new main-topsail, clew-line, and bunt-line. At 4, let double-reefs out of the top-sails. At 6, *strong gales* and squally, furled the topsails and reefed foresail, every appearance of a hurricane. Midnight, heavy gales and hard squalls with rain and a very heavy sea, steering before the wind under the reefed-foresail. A. M., ditto weather, ship making a great deal of water. Noon, heavy gales and hard squalls, a very heavy sea breaking constantly over the ship, pumps constantly at work. Lat. 20° 30′ S., long. 64° 36′.
4	3		"	"	
6	4		N.W.	S.W.	
8	6		East.	West.	
10	6		E.S.E.	W.N.W.	
12	6		"	"	
2	6		S.E.	N.W.	
4	6		"	"	
6	6		South.	North.	
8	6		"	"	
10	6		S.S.W.	N.N.E.	
12	6		"		
					5th April.
2	6		S.W.	N.E.	P. M., heavy gales, hard squalls with rain. At 5, the larboard fore-tack gave way, put a new one and a preventor on the other side. At 6, hard gales and very heavy squalls. At 6h. 30m., the foresail blew out of the bolt-rope, and the ship broached-to and fell over on her broad-side. At 7, found the ship had a great deal of water in but could not fetch the pumps, cut away the main-mast to set her right, and threw over-board about 350 tick boards, 1 lower boom, 1 main-gaff, 1 top-gallant-mast, 2 royal yards, with sails, &c., and scuttle water-casks, with a quantity of 2-inch pine planks from between deck to right her; washed away the principal part of the bulwarks; got the ship again before the wind, all hands to the pumps. Midnight, got the pumps to suck. A. M., very heavy gales and hard squalls; the cook-house, with a great part of the cooking apparatus, washed overboard, and almost every thing on deck, 2 casks of pork, &c. At 5, the
4	6				
6	6		W.S.W.	E.N.E.	
8	2				
10	5				
12	5				
2	5		West.	East.	
4	5				
6	5		W. by S.	E. by N.	
8	5				
10	5				
12	5		S.W.	E.N.E.	

Extracts from the Log of the brig ARGO (*continued*).

Hours	K.	F.	Courses.	Wind.	Remarks.
					5th April (*continued*). gig washed away from the stern, got the long-boat and every thing on deck well secured. Noon, heavy gales and hard squalls. Lat. 22°, long. 62° 56′ E.
					6th April.
2	5		W.S.W.	E.N.E.	P. M., hard gales and heavy squalls with rain and a heavy sea. At 1, the flying-jib flew from the boom, jib and topmast-staysail split to pieces. Midnight, ditto weather. A 1 A.M., very hard gales and heavy squalls with a dreadful sea making a fair breach over the ship, ship making a deal of water, all hands at the pumps. At 6, one of the guns broke adrift, the fore-topsail blew adrift from the yard and went to pieces, sent the fore-yard on deck to save the mast, found the long-boat to be stove in two places. At 8, moderate, got the pumps to suck. At 10, found the main piece of the rudder much shook, put a lashing round it. Noon, strong gales and squally with a very heavy sea. Pumps constantly going. Lat. 22° 40′ S., long. 61° 10′ E.
4	5				
6	5				
8	5				
10	5				
12	5				
2	5		W. by N.	E. by S.	
4	5				
6	5		W.N.W.	E.S.E.	
8	5				
10	2		West.		
12	2				
					7th April.
2	3		W.N.W.	E.S.E.	P. M., strong winds and very heavy sea, ship labouring very heavily. Strong gales and cloudy. Midnight, ditto weather. A. M. Moderate and variable. At 6, moderate and fine, get the fore-yard up. Noon, moderate and fine, pump constantly going. Lat. ob. 21° 10′ S., long. ch. 59° 53′.
4	3				
6	3				
8	3				
10	3		West.	S.E.	
12	3				
2	3		N.N.E.		
4	3				
6	3				
8	3				
10	3				
12	3			S.S.W.	

Extracts from the Log of the brig ARGO (*continued*).

April 8th, wind S.W., weather moderate, in lat. 19° 57′, long. 59° 39′.

9th, wind S.W., fine, lat. 19° 31′ S., long. 59° 48′ E.

10th, wind W.S.W. to N.W., fine, lat. 19° 53′ S., long. 60° E.

11th, wind N.W. to N., light and calm, lat. 20° 9′ S., long. 58° 46′ E.

NO. 4 ON THE DIAGRAMS.

Extracts from the Log of the brig RAMBLER *from Singapore to Mauritius.*

Had fine E.S.E. and S.E. winds from 26th March to 1st April. On the 2nd April, the wind was east, a strong breeze and squally, with rain, lat. 20° 15′, long. 68° E., "a cross sea."

Extracts in full.

Hours	K.	F.	Courses.	Wind.	Lee way.	Remarks.
2	7		W. by N.	East.		3rd April. Commenced with a fresh breeze and rainy weather. At 5 P.M., ditto breeze and cloudy weather, double-reefed the main-topsail, and single-reefed mainsail, and set main-topgallant-sail. Midnight, ditto breeze and cloudy weather, with some light showers of rain and a cross sea, ship rolling, gunwales under water and labouring much. At 6 A.M., ditto weather, pumped off 15 casks of water below and filled ditto with salt water, stowed the main-topgallant-sail, got up two casks of beef out of the after-hold, broached one of them. At noon, ditto weather, ship rolling as above. Lat. 20° 30′ S., long. ch. 66° 3′.
4	6	4				
6	6	4				
8	6	4				
10	6	4				
12	6	4				
2	6	4				
4	6	4				
6	6	4				
8	6	4				
10	6	4				
12	6	4				
2	6	4	West.	East.		4th April. Commences with an increasing gale. At 4 P.M., gale increasing, close-reefed the main-top-
4	6	4				
6	6	4				

Extracts from the Log of the brig Rambler (*continued*).

Hours	K.	F.	Courses.	Wind.	Lee way.	Remarks.
8	6	4				4th April (*continued*). sail, and reefed the foresail, and stowed the fore-topsail. At 8 stowed the main-topsail. Midnight, blowing a mere hurricane and a high sea running, ship rolling, gunwales under water, and shipping some water. At 2 A.M., took in the foresail and run under bare poles. At 8 A.M., got the main-topgallant-yard down upon deck, secured the watches through the night, pumps attended to. At noon, still blowing the same, with a high sea and much rain. Lat. 20° 50′ S., long. 63° 16′ E.
10	6	4				
12	6	4				
2	6	4				
4	4	1				
6	3					
8	3					
10	3					
12	3			E.N.E.		
2	4		West up to north. Off to N.W. by north.	East.		5th April. Commences with a very heavy gale and a high cross sea, ship rolling very heavily and shipping some water on deck. At 6 P.M., blowing a complete hurricane, hove the ship to under bare poles. At 10, part of the fore-topsail blew from the yards in pieces, having broken away the gaskets. At 11, a heavy sea struck the stern-boat, and carried away the foremast ring-bolt that it was lashed to, cut her away at the after-end. Midnight, still much the same and a very high cross sea, ship making some water and rather more than usual. At 8 A.M., rather less wind, ship shipping seas fore and aft, set the fore-top-main-staysail for a storm main-sail. At noon, blowing a heavy gale, pumps attended to. Ship labouring very heavily these twenty-four hours, stove part of the bulwarks and carried away lift and trusses, a sea struck the
4	4					
6	4					
8	2				6	
10	2				6	
12	2				6	
2	2				6	
4	2				6	
6	2				6	
8	2				6	
10	2			N.E.	6	
12	2				6	

Extracts from the Log of the brig RAMBLER (*continued*).

Hours	K.	F.	Courses.	Wind.	Lee way.	Remarks.
						5th April (*continued*). starboard lower boom and broke it to pieces, a great many ropes belonging to the sails and rigging were carried away. Lat. 21° 13′ S., long. 62° 45′ E., by account.
						6th April.
2	2		NWbyN	NE.byN	6	Commences with a very heavy gale, much rain and an enormous high cross sea, ship labouring excessively heavy and shipping tons of water upon deck. At 7 P. M., gale increased to a mere hurricane, split the storm staysail, hauled down ditto, and let the ship drive under bare poles; carried away the head of the fore-topmast-stay during the night, people employed securing the mast, getting the stay set up with a stopper; and carried away the back ropes of the martingale, and many of the other ropes quite destroyed and most of the running gear. At 8 A. M., rather more moderate with a high cross sea, ship rolling as above and chafing the long yards and the rigging, also the shrouds in many places greatly; making water, pumps attended to all night. Noon, more moderate, ship labouring as above, seamen employed in repairing the storm-trysail. Being unable to cook any rice for the coolies, have given the bread and beef, in proportion to the rice, for the last two days. Lat. 22° S., long. 62° 22′ E., account.
4	2				6	
6	2				6	
8	2				6	
10	2				6	
12	2				6	
2	2				6	
4	2				6	
6	2				6	
8	2				6	
10	2				6	
12	2				6	
						7th April.
2	2		NWbyW	N.N.E.	6	Commences with a fresh gale and

Extracts from the Log of the brig RAMBLER (*continued.*)

Hours	K.	F.	Courses.	Wind.	Lee way.	Remarks.
						7th April (*continued*).
4	2			N.N.E.	6	a high beaming sea, ship rolling, lee-rails under water, and shipping tons of water upon deck, finished repairing storm-trysail and set ditto. At 8, heavy gale increasing attended with lightning and rain. Midnight, strong gale and a high confused sea, ship rolling enormously heavy, and shipping water fore and aft, and stove-in some bulwarks starboard side. At 8 A. M., blowing a heavy gale and a high sea, great trouble and difficulty to get anything cooked for the coolies, the ship rolling so violently heavy. At noon, rather more moderate with a high sea as above, and cloudy, hazy weather. Lat. 22° 24′ S., long. 61° 49′ E., account.
6	2				6	
8	2				6	
10	2				6	
12	2				6	
2	2				6	
4	2				6	
6	2				6	
8	2				6	
10	2				6	
12	2			N. by W	6	
						8th April.
2	2		W.N.W.	North.	6	Commences with a fresh breeze and cloudy weather, set up foretop-mainsail and hobstay. At 4, wore ship's head to east, and set fore-topsail close-reefed and reefed foresail. At 8, light winds, and small rain, and a high swell, ship rolling heavily and labouring much, set the mainsail and reefed. Midnight, ditto weather, one seaman sick off duty. At 4 A. M., fresh breeze attended with rain, wove ship's head to N.W. At 7, the foot-rope of the foresail carried away, put on a stopper and set the sail again. At 7, unbent the main-topsail, and bent another and set ditto double-reefed, people employed splicing ropes or running gear. At noon, light
4	2		W.S.W.		6	
6	2		E. by N.		5	
8	2		East		5	
10	2		S.E.byE.		4	
12	2				4	
2	2				4	
4	2		S.E.		4	
6	2		N.N.W.		3	
8	2				2	
10	2		NWbyN		2	
12	2				2	

Extracts from the Log of the brig RAMBLER (*continued*).

Hours	K.	F.	Courses.	Wind.	Lee way.	Remarks.
						8th April (*continued*). breeze and cloudy, out one reef fore-topsail, and let the reefs out of the courses. Lat. 22° 58′ ob., long. 62° 30′ E., account.
2	3		NWbyN	North.		9th April. Commences with a light breeze and dark rainy weather, people reeving some new running gear and splicing ditto fore and aft the ship, and other sundries as found most useful at first. Midnight, moderate breeze and a cross sea, ship rolling and pitching bows under water. At 4 A. M., fresh breeze. At 8 A.M., ditto weather, ship not making so much water as usual. At noon, fresh breeze with fine weather, wove ship's head to N.W., pumps attended to. Lat. 22° 48′ S. ob., long. chr. 62° 44′.
4	3		N.W.			
6	3		East.			
8	3					
10	2	4	E. by N.			
12	2	4				
2	4		E. ½ N.			
4	4	4				
6	3	4	East.	N.N.E.		
8	3	4				
10	4					
12	4					

No. 5 ON THE DIAGRAMS.

Extracts from the Log of the barque BLANCHE.

On the 28th March, fresh breezes and squally, with a heavy sea from the eastward, wind S.E. by S., lat. 13° 27′, long. 77° 10′.

On the 29th, the wind S.E. by S. to S.E., *a heavy cross swell* from the east, *shipping a great deal of water*, lat. 14° 51′ S., long. 74° 46′ E.

On the 30th, wind S.S.E., a strong gale, hard squalls, and a very heavy sea, drizzling rain, three reefs in the topsails, lat. 15° 28′ S., long. 73° E.

On the 31st, a gale, hard squalls with heavy rain and a heavy sea, three reefs in the topsails, wind south, lat. 15° 30′, long. 71° 30′.

April 1st, P. M., wind south, a gale, heavy squalls attended by rain and a high cross sea; 4 A. M., wind S.E.; at daylight, better weather, *out all reefs;* 11 A. M., wind N.E., another gale; lat. at noon, 15° 58′, long. 70° E.

On the 2nd, wind S.E. to N.E., course S.W. by S., during the twenty-four hours; it was blowing strong, squally, rainy, and a heavy sea running, lat. 17° 59′, long. 68° 50′.

On the 3rd, fresh breezes; midnight cloudy with rain; A. M., carrying studding-sails, wind N.E., course S.W. by S., lat. 20° 14′, long. 67° 25′. Bar. 29.85.

On the 4th, P. M., wind N.E., steering S.W. by W., breeze increasing, took in all the studding-sails, &c.; 7 A. M., wind E.N.E.; lat. 21° 59′ S., long. 65° 28′ E. Bar. 29.75.

Hours	M.	K.	Courses.	Wind.	Remarks.
					5th April.
1	7		W.S.W.		Strong breezes with rain and heavy
2					sea.
3					4 P.M., in second reef in fore-topsail.
4	7				At 8, down the royal yards.
5					11, hard squalls, in second reef in
6	7				main-topsail, and stowed the top-
7					gallant-sails.
8	7				Midnight, squally with rain.
9					Shipping a large quantity of water
10	7				over all, found the ship making
11				East.	much water, pumped ship every
12	6	4			hour.
13					Noon, ship labouring very much and
14	6	4		E.S.E.	shipping a large quantity of water
15					over all, sent down the fore-top-gal-
16	6	4			lant yard.
17					Lat. 23° S., long. 62° 36′ E., per ac-
8	6	4			count.
9	6				
10	6				
11	6		W. by S.		
12	6				Barometer 29.52.
					6th April.
1	5		W. by S.		Hard gale attended with squalls and
2	5				heavy sea.
3					At 1 P.M., close-reefed the main-top-
4	5				sail and furled it, and reefed the fore-
5	5				sail. At 2 P.M., a heavy sea broke
6	5				on board and a great quantity of
7	5		West.		water went down into the cabin. At
8	5				10 P.M., very strong squalls, stowed
9	5				the foresail and fore-topsail, and

Extracts from the Log of the barque BLANCHE (*continued*).

Hours	M.	K.	Courses.	Wind.	Remarks.
10 11 12 1 2 3 4 5 6 7 8 9 10 11 12	5 4		Head fromSW. by S. to W.S.W.	S.E. byS.	6th April (*continued*). hove the ship to with head to S.W. At 7 A. M., down top-gallant-mast and mizen-topmast. At noon, hard gale with a very heavy sea running, pumping constantly. Daylight, blowing a hurricane, the ship laying over with the lee-side under water, and the sea making a clean breach over all; during this time the ship making much more water than usual. At 11 A. M., stove the galley and worked away part of it. Noon, still blowing a hurricane with a tremendous sea, ship laying on her beam ends. Bar. 29.40. Lat. 23° 10' S., long. 61° 10' E.
			S.S.W. to W.S.W.		7th April. Hard gale with heavy squalls attended with rain, sea constantly breaking over the ship. At 6 P. M., the sea struck the long-boat, stove her, and carried away the gripes, also washed away a great deal of ship's bulwarks. At 10 P. M., carried away the flying jib-boom and split the sail. At 6 A.M., the sea took away seven water casks off the deck, the studding-sails getting washed to pieces, being obliged to throw overboard the forecastle, and scuttle, and cabin companion; washed the weather rail away, which struck the main-hatch tarpaulin and tore a hole in it, nailed a piece of canvass over it;—barometer rising;—found the ring-bolts of the deck, on the larboard side, to which the boat-gripes were fastened, started away. Noon, more moderate, barometer rising. Bar. 29.30 Lat. 23° S., long. 59° 40'., (lat. 23° 30' ?)
			SW. byS. to W. byS		8th April. Hard gale with heavy squalls and very heavy sea, pumps going constantly. At 10 P.M., the sea took four water

Extracts from the Log of the barque Blanche (*continued.*)

Hours	M.	K.	Courses.	Winds.	Remarks.
					8th April (*continued*). casks off the deck. At 10 A.M., the sea struck the rudder and split it, got chains on it and secured it. At 10h. 30m., the sea struck midships' dead light and knocked it in, found the rudder split from head down to the 2nd pintle, working nearly round at every sea. At noon, more moderate, barometer rising, found the rigging much chafed, and great many of the running gear washed away, and broke to pieces all the sails, canvass, twine, &c. Lat. 23° 30′ S., long. 58° 20′ E., per account (long. 59°?).
1			SW.byS.		9th April. More moderate. At 10h. 30m., set the main-trysail, 10 P.M., set the main-topsail, pump constantly going. At 10 A.M., set the fore-topsail. Lat. ob. 23° 24′ S., per account 23° 46′ S. Long. per chr. 58° 40′ E., per account 58° 26′.
2				S.E.byS.	
10	2				
A.M.					
7	1	4			
10			S.W.		
12			W. by S.	S. W.	

10th April, wind S.W. to W.N.W., squally and fresh breezes, lat. 22°, long. 58° 4′.

11th April, wind N.W. to N.N.W., moderate, lat. 20° 59′, long. 58° 11′ E.

12th April, wind N.W. and calm—fine—saw Mauritius.

No. 6. ON THE DIAGRAMS.

Extracts from the Log of the ship Broxbournbury.

23rd March, 1843, wind west to W.S.W, course S.S.E., fresh breezes and squally, lat. 6° 5′ S., long. 78° 50′ E.

On the 24th, 2 P.M., wind S.W. by W., squally with rain; at 4, hard squalls and incessant rain; at 6, wind variable; at 8, wind E.N.E.; at midnight, wind W.S.W.; at 4 A. M., W.N.W.; at 10, west; lat. 7° 28′ S., long. 79° 10′ E.

Extracts from the Log of the ship Broxbournbury (*continued*).

On the 25th, 2 p.m., wind at W.S.W., variable breezes, gloomy weather, and occasional squalls; at 8 p.m., calm; at 2 a.m., wind S.S.E.; at 10, wind south; lat. 7° 47′ S., long. 79° E.

On the 26th, 2 p.m., wind S. by W., unsettled and squally, fresh breezes, and *two reefs* in the topsails; at 8 p.m., wind S.W. by W.; noon, wind S. by E.; lat. 8° 52′, long. 79° 10′ E.

On the 27th, the wind S.E. and course S.W. by south, strong breezes and cloudy; lat. 10° 20′, long. 78° 28′ E.

On the 28th, 2 p.m., wind S.E., fresh breezes and hard squalls with lightning to the westward; 4 a.m., wind S.E. by S., two reefs in the topsails; 8 a.m., S.S.E.: daylight, heavy squalls, sent down the royals; lat. 12° 22′ S., long. 76° 7′ E., course S.W. by S., 7 miles.

On the 29th [*in front of the gale*], 2 p.m., wind S.E. by E., strong breezes, squally with rain; 12, S.S.E., steering S.W.; 6 a.m., wind S. by E., steering S.W. by W.; lat. 14° 10′, long. 74° 32′.

On the 30th, 2 p.m., wind S. by E., course during the twenty-four hours W.S.W., 7 miles per hour; 2 a.m., wind south, a fresh gale, squally, cloudy and heavy sea, with much rain; 4 a.m., S. by W., two reefs in the topsails; 10 a.m., south, mizen-top-gallant-yard sent down; lat. 15° 3′, long. 72° 21′ E.

On the 31st [*diverging from the vortex*], wind south, ship steering W. by S.¼S.; after midnight, violent squalls, ship straining heavily and shipping a good deal of water; three reefs in the topsails, and at noon lat. 15° 17′, long. 70° 24′.

On the 1st April [*north of the focus*], fresh gales, squally with rain; a.m., heavy squalls with rain and lightning, increasing appearance of bad weather, stowed fore-topsail, close-reefed main-topsail; 2 p.m., wind south, course W.S.W.; 12, wind S. by W., course W. by S.; 4 a.m., wind S.S.W., course W. by N., moderate, and lightning all round; noon, S.W. by W., moderate and thick, sent down top-gallant-yards; lat. 15° 19′, long. 69° 25′.

On the 2nd [*behind the centre*], fresh gales and thick weather; 5 p.m., a heavy squall from N.W.; 6, wind S.W. by W., course W. by N.; 8, wind N.W., course S.E., strong gales, ship straining and labouring much; 10, wind N.W., course S.W. by S. 5; 12, wind N.W., course S.W. 6; fresh gales, heavy rain, a swell from S.S.W., making the ship very uneasy; 8 a.m., wind N.N.W., course S.W. by W. 7; at daylight, set the mainsail; 10, wind N.N.W.; noon, strong breezes; Lat. 16° 31′, long. 68° 19′.

Extracts from the Log of the ship BROXBOURNBURY (*continued*).

Hours	K.	M.	Courses.	Wind.	Remarks.
					3rd April.
2	6		SW. by S.	N.N.W.	Begins with fresh breezes and cloudy, people employed as most useful. At 4 P. M., ditto weather, stowed the mizen-topsail. At 8, strong breezes and clear, in mainsail, pumped ship at 17 inches. Midnight, fresh breezes and squally, with light showers of rain. A. M., ditto weather, strong breezes and cloudy. Daylight, main-top-gallant-mast, pumped ship every two hours. At 8, strong breezes and cloudy, shifted the third fore-topsail, with second main-topsail, with best one. Noon, fresh breezes with hazy weather. Lat. 18° 31′ S., long. 66° 57′ E. Barometer, 29·66 to 29·42.
4	6			,,	
6	6			North.	
8	6			NE. by N	
10	6		S.W.	N.E.	
12	6				
2	6				
4	6				
6	6				
8	6				
10	6				
12	6				
					4th April.
2	6	4	S.W.	N.E.	Begins with moderate breezes from west, people employed repairing the main-topsail. At 4 P. M., ditto weather; 5, up main-top-gallant-yard; at 6, set ditto; 10, close-reefed the fore-topsail. Midnight, heavy squalls, with rain, took in main-top-gallant-sail, in three reefs main-topsail. A. M., squally with lightning. At 4, ditto weather, with passing showers, heavy sea running and ship labouring much. Daylight, ditto weather, pumped ship every two hours. At 8, strong gales and squally, ship rolling heavily, taking much water on deck. At 8h. 30m., watch employed in sending down main-top-gallant-yard, and housed the main-top-gallant-mast and flying jib-boom. Noon, strong gales and heavy squalls, ship straining and rolling heavily, shipping a great quantity of water on deck. Lat. 20° 45′, long. 65° 18′ E. (Lat. 20° 42′, long. 64° 50′ E., Capt. Burnett's correction).
4	6	4			
6	6	4			
8	7	4		NE. by N	
10	8				
12	8				
2	8				
4	8				
6	7				
8	7				
10	8				
12	8				

Extracts from the Log of the ship BROXBOURNBURY (*continued*).

Hours	K.	M.	Courses.	Wind.	Remarks.
					5th April.
2	8		S.W.	NE.byE.	Begins with strong gales and heavy squalls passing. At 4, heavy squalls with rain, ditto weather, pumped ship at 10 inches. Midnight, heavy squalls with rain. A.M., ditto weather, in foresail, heavy gale and increasing, close-reefed the main-topsail, ship labouring heavily, shipping much water on deck. 4h. 30m., Mr. Fleak died on board. At 5, heavy gales, ship labouring heavily, in topsails, ship scudding under the top and lower mast, and straining and labouring very heavy, and shipping heavy seas on deck, pumped ship every half hour. At 10, hove-to under the masts, ship labouring heavy. Noon, heavy gales with a heavy sea and incessant squalls with rain. Lat. 22° 49′, long. 63° 16′ E. (Lat. 22° 20′ S., long. 62° 30′ E.?) Bar. 29·30.
4	8				
6	8				
8	8				
10	8		W.S.W.	E.N.E.	
12	8				
2	8		West.		
4	8			East.	
6	8				
8	8				
10	7	4			
12					
					6th April.
2			S.S.W.	East.	Begins with heavy gales and violent squalls with heavy rain, ship lying-to under the above masts, and straining and labouring heavily, and shipping a great deal of water, a heavy sea running. At 8, ditto weather, ship labouring heavy. At 10, ditto weather, pumping ship constantly, 4 feet 10 inches in the well. Midnight, heavy gales and violent squalls, ship labouring heavy. At 1h. 30m. A.M., shipped a heavy sea and took away the gig and the lower quarter gallery on the starboard side, and some of the bulwarks on the lower side. At daylight, ditto weather with violent squalls and incessant rain, ship labouring and striking heavy on the starboard side, shipping heavy seas on deck, washed away the starboard anchor. At 10, cast the corpse
4					
6					
8					
10				E.S.E.	
12					
2					
4					
6					
8					
10					
12			South.	East.	

Extracts from the Log of the ship BROXBOURNBURY (*continued*).

Hours	K.	M.	Courses.	Wind.	Remarks.
					6th April (*continued*). of Mr. Fleak to the deep. At 11h. 20m., washed away the remainder of the bulwarks of the main-deck on the starboard side, all the crew employed in pumping constantly. Noon, more moderate and incessant rain, ship labouring heavy. Lat. 22° 49′, long. 62° 50′ E. (Long. 61° 40′ E. ?)
2			South	E.S.E.	7th April. Begins with a heavy hurricane from the S.E., ship straining and labouring and shipping heavy seas on deck, all hands employed pumping ship, ship making much water. 4 A.M., ditto weather with violent squalls and heavy rain. At 8, ditto weather, ship striking very heavy abaft. Midnight, ditto weather with a heavy sea running. 3 A.M., ship wove round on the starboard tack, carried away the cutter from the larboard quarter, larboard bulwarks and staunchеons, and on main deck all hands at the pumps. Daylight, ditto weather, larboard gun washed away. Noon, heavy hurricane, ship can no longer lie-to, kept away before the wind to save ship and crew. Passed a vessel (*The Waverley*) with her foremast and main-topmast gone, bearing S.E. Lat. 22° 56′, long. 62° 4′ E. (Lat. 22° 35′, long. 61° 35′ per Captain's corrections), (long. 60° 40′ E. ?) Bar. 29·30.
4					
6					
8					
10					
12					
2					
4			N.E.	S.E.	
6					
8					
10					
12				S.S.E.	
2	7		North.	S.S.E	8th April. P.M., begins with a heavy hurricane from S.E. to south and S.W., all hands employed at the pumps, ship straining and labouring heavy, shipping heavy seas on deck. At 3h. 30m., John Hugre, boat-swain, washed overboard from the larboard
4	7			South.	
6	7				
8	7				
10	5				
12	5			S.W.	

Extracts from the Log of the ship BROXBOURNBURY (*continued*).

Hours	K.	M.	Courses.	Wind.	Remarks.
2	3	4			8th April (*continued*). channel, no assistance could be given, all our boats are washed away from the quarters, the larboard anchor washed overboard. 6, ditto weather. 8, moderate with violent squalls, set the main-topsail. Midnight, more moderate with rain and a heavy swell from the south, ship rolling heavy, all hands employed pumping ship. At 4 A.M., set the foresail, jib, and mizen. At 8, fresh breezes and squally with rain. Noon, ditto weather; sick list — Mr. Connor, 2nd officer, John Ritwood and John Boode, seamen. At 12, cast the corpse of Allan Morne to the deep. Lat. 21° 16′ S., long. 62° 24′ E. Lat. 21° 32′, long. 60° 12′, Captain's correction.
4	3	4	N.W.		
6	3	4			
8	3	4			
10	3	4			
12	3	4			
2	3	4	N.W.	SW.byS.	9th April. Begins with moderate breezes and squally with rain, watch employed at the pumps, bent the best fore-topsail and staysail. At 8, ditto weather with a swell from the south. Midnight, ditto weather. A.M., ditto weather. Daylight, ditto weather with passing showers, out all reefs mizen-topsail. 8, moderate and squally with passing showers. Noon, moderate, fine weather. Lat. 20° 13′ S., long. 59° 35′ E.
4	3	4			
6	3	4			
8	3	4			
10	3	4			
12	3	4			
2	3	4			
4	3	4			
6	3	4			
8	3	4	W.N.W.		
10	3	4	"		
12	3	4			

On the 10th April 1843, wind W.S.W. W.N.W., the gale over; "*spoke the Velore at* 3 P.M.," lat. 59° 19′ S., long. 20° 45′ E.

On the 11th, wind W.N.W., N.N.W., north, fine weather and light breezes, lat. 20° 35′, long. 59° 2′ S.

On the 12th, wind N.E., sighted Mauritius.

No. 7. ON THE DIAGRAMS.

Extracts from the Log of the ship SEA QUEEN.

25th March, 1843, wind S. by W., a long swell from south, lat. 7° 58′ S., long. 82° E.

On the 26th, wind S.W., south, and S.E., squally and gloomy appearance, raining, "supposed to be the commencement of the trades," lat. 8° 49′ S., long. 81° E. A heavy southerly swell.

On the 27th, wind S.S.E., squally with rain, moderate at times; course S.W. by S.; lat. 11° 8′ S., long. 80° 47′ E.

On the 28th, wind at S. by E. and S.E., "fresh trades, squally, gloomy, rainy;" course W.S.W.; lat. 12° 30′, long. 77° 56′.

On the 29th, wind S.S.E., squally, lat. 14° 15′, long. 75° 30′.

On the 30th, wind S.S.E. to south, gloomy and squally weather with rain, strong breezes, mainsail stowed, two reefs in topsails. Noon, heavy squalls; lat. 15° 10′, long. 73° 10′.

On the 31st, wind south to S.S.E., squally, and heavy rain; lat. 15° 37′, long. 71° 20′ by account. Sent down royal yards.

On the 1st April, 8 P.M., wind S.S.E.; 11 P.M. *south;* 2 A.M. S. by E.; 3, at *west;* 4, N.W.; 9, *north;* midnight N.E. Heavy gales. At 4 P.M., lightning and thunder, incessant rain. 8 P.M., very heavy squalls, a high cross sea running. 2 A.M., very threatening. At noon, split the mainsail; lat. 15° 45′, long. 70° 10′ E. by account.

On the 2nd, wind N.E. and N.N.E., strong breezes, squally, a heavy sea running, ship rolling heavily and shipping water on board. Noon, more moderate; lat. 18° 42′, long 69° 25′.

On the 3rd, wind N.E. to east, more moderate but a heavy sea running, and ship labouring much; lat. 20° 14′, long. 68° 16′.

Hours	M.		Courses.	Wind.	Remarks.
					4th April.
2	7		W.S.W.	East.	Moderate breezes and fine weather, bent main-topgallant-sail, main-royal-yard and set the sail, and topmast staysail.
4	7				
6	7				
8	7				
10	7				Ditto weather.
12	7				Throughout the night strong breezes and a heavy swell of sea, ship rolling and labouring heavily.
2	7				
3			W. by S.		At 2 A.M., took in the staysails.

Extracts from the Log of the ship Sea Queen (*continued*).

Hours	M.	K.	Courses.	Wind.	Remarks.
					4th April (*continued*).
4	7				At 4 a.m., ditto winds and cloudy, vessel shipping a great deal of water; water in well 13 inches; pumped ship, sent down main-topmast-stay-sail-boom on deck. Noon, breezes strong and hazy weather, ship rolling heavily and shipping much water. Lat. 21° 20′, long. 65° 30′ E., account.
6	7				
8	6		West.		
10	6				
12	6				
					5th April.
1	7		W.S.W.	E.N.E.	Strong winds and squally with rain, employed securing the hatches, &c., ship rolling heavily and shipping a good deal of water, took in the main-topgallant-sail. At 5h. 30m., increasing winds and fair weather, second reef fore-topsail and single reef in main-topsail, furled mainsail and fore and aft sails. At 6 p.m., strong steady winds and fair weather, down top-gallant yards and housed top-gallant masts. Throughout the night strong winds and fair weather. At 4 a.m., blowing heavy with constant heavy rain; turned up hands, hoisted up the foresail, close-reefed the main-topsail and set it. At 8 a.m., increasing gales, ship rolling, and straining, and shipping a great deal of water; furled the foresail and cleared up the fore-topsail and furled it, and brought the ship to under close-reefed main-topsail and fore-topmast-staysail. Noon, heavy gales and constant rain. Lat. 22° 13′, long. 63° 11′ E. Captain's correction, lat. 22° 40′, long. 61° 47′. (Long. 62° 40′?)
2	7				
3	7				
4	7				
5	8				
6	8				
7	8			East.	
8	8				
9	8				
10	8				
11	8				
12	8				
1	8				
2	8				
3	8				
4	8				
5	8			E.N.E.	
6	7				
7	6				
8	6				
9					
10			Hove to.		
11			S.S.W.		
12			„		

Remarks on 6th April.

East E.S.E. course S.S.W., 4 knots, heavy gale and violent squalls, constant rain, and thick weather, ship rolling heavy and straining,

Extracts from the Log of the ship SEA QUEEN (*continued*).

Remarks on 6th April (*continued*).

shipping seas very fast. Battened down the hatches fore and aft, and secured the ports, passed preventer-gaskets round the sails, secured boats and spars. Blew fore-topmast staysail to pieces. 8, violent gales, with a tremendous sea running; 10, heavy gusts of wind; midnight, thick rainy weather, lost the jolly boat from the stern; 2 A.M., carried away the jib-boom and F. royal-mast; daylight, moderate, cut away the wreck forward, secured the yards with preventer parcels and braces; 9h. 30m., rolling gunwale under water, carried away main-topmast over the side, impossible to cut away the wreck, ship rolling so heavily and rolling gunwale under, hauled aft the main-trysail sheet to steady her, but the wreck soon tore it to pieces.

At 10 A.M. carried away the iron-tiller of the rudder, about nine inches from the head; got stauncheons from each side, and secured it. Having no tiller or hole in the rudder-head to ship it into, hauled the driver out to keep the ship steady. At noon split the driver close-reefed to pieces, got an awning up and down the mizen rigging. Blowing most violently, with a tremendous sea, and rolling gunwales under. Pumped ship every two hours, but ship not making more than one or two inches water per hour. Threw the water casks overboard to clear the decks.

At 8 A.M. the commanding officer of the troops kindly volunteered to attend the pump, and divided his men into watches; and for that duty also stationed sentries over the hatches and lights in the gun decks to protect the spirits and powder below. Lat. 22° 55′, long. 60° 23′, by the captain's account. Wind E.N.E. to S.E. Lat. by log, 22° 23′ S. (Lat. 22° 30′, long. 61° 20′ E.)

7th April.

At 2 P. M., heavy gale, ship labouring in the trough of the sea, gunwale under, not having any after sail to keep her head to the sea.

At 4 P.M. *moderated a little*, occasioned her to strain very much and ship seas constantly, with heavy rain. 6 P.M., vivid lightning and very many squalls, with sudden calms for a few moments.

At 8 P.M. *blowing violently*, fore topsail blew adrift, ship's head W.N.W. and veered to S.W. At 10 P.M. carried away the fore topmast, and the foresail got loose and blew to pieces.

Midnight, blowing a perfect hurricane, with a tremendous cross sea running, and the ship rolling most violently. Raining very

Extracts from the Log of the ship SEA QUEEN (*continued*).

Remarks (*continued*).

heavily, and constant vivid lightning during the night; ship at the mercy of the wind and waves, with the helm lashed a-lee.

At 1 h. 30 m. a furious gust carried away the main-mast close by the deck, which fell on the poop (starboard side), with the wreck of main topsail.

At 2 h. 30 m., the mizen-mast having no support, fell over the taffrail, destroying the binnacle wheel and gig on larboard quarter.

At 4 A.M. still blowing furiously, and ship rolling in the trough of the sea. Daylight, blowing a hard steady gale from S.W. and raining heavily. Ship labouring very heavily, and shipping seas over all. The foremast, with the wreck of the topmast, swinging about most fearfully, every moment expecting to see it go over the side, and unable to clear away any of the wreck from the violent rolling and motion of the ship. 8 A.M., hard gales from S.W. Noon, same weather, ship's head N.N.W., drifting 1¼ mile per hour. Lat. 22° 23′. long. 60° 20′ S.

8th April.

At 8 P.M. moderated a little, cleared away the head of the main-mast and mizen-mast from the stern, and the main topmast from the quarter, but unable to do anything with the wreck of the fore top-mast forward. At 8 A.M. got a stay and a pair of shrouds on the foremast to save it, if possible, and assist in gaining some port of safety; but could not succeed in getting them up. Sunset, still blowing a heavy gale, with a tremendous heavy sea running, and constant rain; the ship rolling fearfully in the trough of the sea, and shipping water fore and aft over all, and unable to keep the fire in for cooking for nearly three days.

Midnight, gale decreasing, but still blowing hard, and the ship rolling heavier than ever, and quicker. A heavy cross sea running, ship shipping water frequently over all. The sky breaking up and every appearance of the gale being over. Daylight, fresh S.W. winds with confused cross sea running *westerly;* got the ship's crew on the poop, and trunched the mizen-mast over the stern; commenced securing the foremast with a stay and pair of shrouds on the starboard side, the whole of them being carried away and all but the after pair on the larboard side. The carpenter fitting a preventer tiller on the rudder head, and part of the crew clearing away the wreck of the main-mast and main-yard. Noon, gale decreasing and less sea; opened the hatches, after having been battened down three

Extracts from the Log of the ship SEA QUEEN (*continued*).

Remarks on 8th April (*continued*).

days, and let in the air below, and fortunately there has not been any person seriously injured during the gale.

Noon, lat. ob. 21° 53′, long. 60° 37′ per chr.

9th April.

P.M., strong winds, lulls at times, with passing showers of rain; employed in securing the foremast and foreyard with a topsail sheet for a . At 8 A.M., more moderate, with passing showers of rain, bent the fore-topmast-staysail, wind northerly. Throughout the night moderate weather and cloudy, ship rolling heavily. Daylight, turned-to all hands, fitted lifts, &c. for the foreyard and bent the old fore-topsail, single-reefed, for a foresail; launched the mainmast overboard, after nearly staving in the bulwarks, and got it clear of the ship, and clearing away the wreck, &c.

Ob. lat. 21° 26′, long. 60° 21′ E. per chr.

10th April.

Moderate, fine weather; employed clearing away the wreck, setting up the starboard foreyards, and clearing away to get the fore-topmast down on deck, which is hung and jammed well with the slings of the foreyard. 8 P.M., ditto weather, wind at north. Throughout the night, moderate and fair weather. Daylight, commenced reefing to get the fore-topmast on deck clear of the foreyard. Noon, fine clear weather; 11 inches in well.

Lat. ob. 20° 18′ S., long. 60° 18′ chr.

11th April.

Employed about the fore-topmast. 2 P.M., succeeded in getting it on deck in safety, took off the cross-trees and purchases, secured it on deck, afterwards secured the foreyard. 8 P.M., light winds N.N.W. to N.N.E. Throughout the night ditto weather. Daylight, called all hands, reefed topsail, fore-foresail, and employed in getting the fore-topsail launched aft on the poop for the carpenters to fit as a mainmast and looking for rope for rigging.

Lat. 21° 22′, long. 60° 36′ E.

No. 8. ON THE DIAGRAMS.

Extracts from the Log of the barque VELORE, *from Calcutta to Mauritius. A light ship. Coolies on board.*

26th March, 1843, wind S.S.W., lat. 9° 47′, long. 83° 45′, bar. 29.60, ther. 84, all sail.

On the 27th, wind S.E., lat. 11° 5′, long. 81° 41′, bar. 29.50, ther. 84, fresh gale.

On the 28th, wind S.E., lat. 13° 52′, long. 79° 36′, bar. 29.60, ther. 84, single-reefed topsails.

On the 29th, wind E.S.E., lat. 15° 20′, long. 76° 58′, bar. 29.55, ther. 84, two reefs in the topsails.

On the 30th, wind S.S.E., lat. 16° 7′, long. 75° 10′, bar. 29.45, ther. 84, close-reefed topsails.

On the 31st, wind S.E., lat. 16° 15′, long. 71° 12′, bar. 29.46, ther. 84, close-reefed topsails.

1st April, wind S.S.E. to S.E., course S.W., scudding, heavy gales, dirty weather, rainy. 2 A.M., lightning, thunder, and rain. Three reefs in the topsails. Run 164 miles in twenty-four hours. Lat. 18° 48′, long. 69° 33′.

On the 2nd, wind E.S.E. and S.E., squally, wild, unsettled, at one time carrying top-gallant-sails, and the next close-reefed topsails. Course 188 miles to S.W. Lat. 19° S., long. 65° 47′.

Hours	K.	F.	Courses.	Wind.	Lee way.	Remarks.
						3rd April.
1	8		W. by N.	E. by S.		P.M., strong trades and squally with rain, two-handed the mainsail, in mizen and main-topgallant-sail. 2h. 30m., in second and third reefs main-topsail, and second and third reefs from topsail, and up fore-sail. 4, more moderate, set foresail. 6, strong gales and squally with rain; well, 9½ inches.
2						
3	8	4				
4	7					
5	7					
6	7					
7	7					
8	7					
9	7					
10	7					
11	7					
12	7					Midnight, strong gales and squally, ship labouring heavy and shipping a great quantity of water on deck, the sea continually breaking on board. A.M., strong gales and squally, with rain at times. 4, strong
1	7	4	W. by N.			
2	7	4				
3	8	4				
4	8	4				
5	7	4				

Extracts from the Log of the barque VELORE (*continued*).

Hours	K.	F.	Courses.	Wind.	Lee way.	Remarks.
						3rd April (*continued*).
6	7	4				gales, pumped ship at 10 inches with a heavy sea, ship labouring very heavy and shipping great quantities of water, the sea continually breaking on board, and strong gales, and squally, with rain. Noon, increasing gale with rain, close-reefed the topsails and reefed the foresail, ship shipping a great quantity of water, a heavy cross sea. Sun obscure. Lat. 20° 47′, long. 63° 10′, account. (Lat. 20°.)
7	7		W. by N. ½ N.			
8	7					
9	7					
10	7	4				
11	7	4				
12	7	4	W. ½ N.	E.		
						4th April.
1	7		West.	E. by S.		P.M., strong gales and squally with heavy rain. 2h. 30m. hauled main-topsail and foresail. 4, increasing gales and squally with heavy rain. 6, hard gales with heavy squalls, wove ship to the northward, hauled the fore-topsail and brought the ship to under larboard reef main-trysail. At 8, wove ship to the westward, hard gales with heavy squalls and rain. 9h. 30m., starboard lower boom washed away.
2	7					
3	6					
4	6		W.N.W.			
5	6					
6	6					
7	1		Up E.		7	
8	1		Off N. E. by E.		7	
9	1		Up S.W.	S.S.E.	7	
10	1		off W by S		7	
11	1				7	
12	1			S.E.	7	
1	1		Up S.W.	S.S.E.	7	Midnight, hard gales with heavy squalls and constant heavy rain; ship labouring heavily and shipping great quantities of water.
2	1		off W by S		7	
3	1				7	
4	1			South.	7	
5	1				7	
6	1		Up W.		7	A.M., increasing gales with heavy squalls and heavy rain. 4, gale increasing and a heavy sea. 6, gale increased to a perfect hurricane, blowing the sails adrift from the yards; a heavy sea running, labouring heavily and shipping much water. 8, wore ship to the southward. Noon, hard gales
7	1		off W N W		7	
8	1			S.S.W.	7	
9	1		Up S.S.E	S.W.	7	
10	1		Off S.E.		7	
11	1				7	
12	1		Up SSW Off S.	W.S.W.	7	

Extracts from the Log of the barque VELORE (*continued*).

Hours	K.	F.	Courses.	Winds.	Lee way.	Remarks.
						4th April (*continued*). with heavy squalls and a heavy cross sea; ship labouring heavily and shipping great quantities of water. Sun obscured. Lat. 19° 27′, long. 62° 36′ E. *See Barometer at page* 181.
1	1		Up S.W. by S.	W. by N.	7	5th April. P.M., strong gales with a heavy cross sea, ship labouring heavily and shipping much water; sent down top-gallant-yard. At 4, strong gales with heavy squalls. 8, hard gales with a tremendous heavy sea. Midnight, strong gales with light rain at times. A.M., strong gales and squally, with small rain at times. 4, more moderate weather. Daylight, set fore-topmast-staysail, fore-trysail, and reefed mizen. At 6h. 45m., saw the island of Rodriguez bearing N.E. by E., distance 405 leagues. Noon, more moderate, with a heavy N.W. sea; set close-reefed fore and main-topsail. Lat. 19° 57′, long. 62° 50′ E.
2	1		off S by W		7	
3	1				7	
4	1				7	
5	1		Up S.W.	W.N.W.	7	
6	1		Off SSW.		7	
7	1		Up S.W. by W.	NWbyW	7	
8	1		Off S.W. by S.		7	
9	1		up WSW	N.W.	7	
10	1		Off S.W.		7	
11	1				7	
12	1				7	
1	1		Up W.	N.N.W.	7	
2	1		off WSW		7	
3	1				7	
4	1				7	
5	1		up WbyS	NWbyN	7	
6	1		Off S.W. by W.		7	
7	1				6½	
8	1				6	
9	1		Up W.	N.N.W.	5	
10	1	4	off WbyS		5	
11	1				5	
12	1	4			5	
1	2	4	W. by N.	North.	2	6th April. P.M., strong gales with squally appearance, ship pitching very heavy. 4, fresh gales and squally, sent in flying jib and boom.
2	2	4			2	
3	3				2	
4	4		W.S.W.	N.W.	2	
5	4				2	
6	4		N. by S.	NWbyN	2	

Extracts from the Log of the barque Velore (*continued*).

Hours	K.	F.	Courses.	Winds.	Lee way.	Remarks.
						6th April (*continued*).
7	2		Up W. by N.	N. by W.	2¾	6, squally, appearance of bad weather, hauled main-topsail.
8	2		Off W½N		2¾	8, fresh gales and squally with small rain at times.
9	2	4	upWNW	North.	2¾	
10	2	4	Off W.		3	Midnight, moderate gales and clear weather. Moderate gale and clear.
11	2	4			3	
12	2	4			3	
						4 A.M., decreasing gales and cloudy with rain at times. Daylight, set main-topsail and foresail out close-reefed, set the jib. A sail on lee-boom standing to the southward. Out third reef topsails and reefs of the courses and mizen, set gaft-topsail.
1	2		upWNW	North.	3	
2	1	4	Off W½S.		3	
3	1	4			3	
4	1	4			3	
5	1	4	W. by N.	N. by W.	4	
6	1	4			4	
7	3	4			2	
8	3	4			2	
9	3	4	W.N.W.	North.	2	At 11, out second reef main-topsail.
10	4	4	NW byN	N. by E.	2	
11	5		W. by N ½ N.	N. by W.	1½	Noon, fresh breeze and cloudy. Lat. 20° 8′ S., long. 62° 10′ E.
12	5	4			1	
						7th April.
1	4		W. ½ N.	N.W.		P.M. Strong breeze and squally with rain. Out second reef of the topsails, hoisted topgallant-yards.
2	4					
3	4		West.	N.N.W.		
4	4					
5	4	4				2h. 30m., set main topgallant-sail.
6	4	4				4h., moderate breeze and cloudy.
7	4	4				At 7h., in gaft-topsail and main-topgallant-sail.
8	4	4				
9	4	4				At 8h., strong breeze and cloudy, in second reef of the topsail.
10	4					
11	4					Midnight, strong breeze and squally at times.
12	4					
						A.M., strong breeze and squally.
1	4	4	W. by S.	NW byN		At 3h. 30m., set main-sail.
2	4	4				At 4h., moderate breeze and cloudy, with rain.
3	4		W.S.W.	N.W.		
4	4	4				At 5h., wore ship to the westward.
5	4	4	S. by W.	W. by S.		
6	4		W.byN ½ N.	S.W. ½ S.		At 8h., strong breeze with a heavy S.W. swell; out second reef fore-topsail; set main-topgallant-sail.
7	5					
8	5					

Extracts from the Log of the barque VELORE (*continued*).

Hours	K.	F.	Courses.	Wind.	Lee way.	Remarks.
						7th April (*continued*).
9	5	4	W.N.W.	S.W.		At 10h., in second reef fore-top-
10	5	4				sail, and furled main-topgal-
11	4	4				lant-sail.
12	4					Noon, fresh breeze with a heavy
						S.W. swell.
						Lat. 20° 25′ S., long. 60° 30′ E.
						8th April.
1	5		W.N.W.	S.W.	1	P.M., strong breeze with passing
2	5				1	squalls. Watch as most useful.
3	5	4	W by W ½ N.	S.W. ½ W.	1	At 3h., set main-topgallant-sail.
4	5	4			1	At 4h., fresh breeze and cloudy,
5	6		W.N.W.	S.W.	1	with a very heavy S.S.W.
6	6				1	swell.
7	6				1	At 6h., increasing breeze and
8	6				1	cloudy.
9	5	4	SW.byW	SW.byW	1	At 8h., steady breeze and fine
10	5	4			1	clear weather.
11	6				1	At 9h., set fore-topgallant sail.
12	6				1	Midnight, fresh breeze and fine
						clear weather with a very
1	6		N.W. by W. ½ W.	SW.byW	1	S.S.W. swell.
2	6				1	A.M., fresh breeze and cloudy.
3	6				1	At 4h., steady breeze and cloudy
4	5				1	with a heavy sea from the
5	5		W.byN.½ N.	S.W.½W.	¼	S.S.W.
6	5				1¼	Daylight, out second reefs of the
7	4		W.N.W.	S.W.	1½	topsails.
8	4				1½	At 8h., decreasing breeze and
9	4	4			1½	fine.
10	5		W.byN.½ N.	S.W. ½ S.	1½	Noon, steady breeze and fine
11	5				1½	weather, out first reef fore-top-
12	4	4	W. by W.	S.W.S.	1½	sail, tacked ship to the S.E.,
						a strong northerly current.
						Lat. 19° 28′, long. 58°.

On the 9th, in lat. 20° 3′, long. 58° 58′, wind S.W., fine, a heavy southerly swell.

On the 10th, lat. 20° 43′, wind W. to N.N.W., at 3 P.M. spoke the *Broxbournbury*.

No. 9. ON THE DIAGRAMS.

Extracts from the Log of the KATHERINE STEWART FORBES, *from Singapore to London,* 1843.

On the 23rd March, 1843, wind S.W. to E. by S., *squally and heavy rain,* lat. 11° 25′, long. 98° 46′ E.

On the 25th, wind E.S.E., in lat. 11° 59′ S., long. 95° 52′ E.

On the 26th, wind E.S.E., in lat 13° 34′ S., long 92° 31′ E.

On the 27th, wind S.E., in lat. 14° 48′ S., long. 89° 20′ E.

On the 28th, wind S.E. to east, *heavy swell, running west, squally* and showery. Topgallant sails set. In lat. 15° 44′, long. 86° 25′ E.

On the 29th, wind E. by N., "*dirty weather, heavy rain and severe squalls.*" "Shipping seas over all." Carried away some sails. Lat. 16° 20′, long. 83° 18′.

On the 30th, wind E. by N., more moderate but heavy rain. Set studding-sails. Lat. 17° 20′, long. 81° E.

On the 31st, wind east, "*unsteady trades, strong winds, heavy sea, constant rain,* split main-royal and foretop-staysail, lat. 17° 45′, long. 78° 39′."

On the 1st April, wind east, "strong variable trades," rainy, latter part more settled, carrying studding sails, lat. 18° 28′, long 75° 59′.

On the 2nd, wind east, light wind, variable, calm, at 6 P.M. "A beautiful starlit night," followed by a "delightful morning, and every appearance of a fine day," lat. 18° 51′, long. 73° 58′.

On the 3rd, wind E. by N., fine, lat. 19° 13′ S., long. 72° 5′ E.

On the 4th, wind E.N.E., steady trades, fine weather. The "night beautifully fine and starlit." Lat. 20° 21′, long. 70° 8′ E.

On the 5th, wind E.N.E., fine weather, beautiful night, carrying studding-sails, lat. 21° 32′, long. 68° 20′.

On the 6th, wind E.N.E., course W.S.W., first part fine, latter part squally, "*heavy rain and a confused sea,*" ship rolling heavily and shipping water over all. Midnight, *every appearance of a breeze,* heavy swell arising from S.E., ship rolling awfully; in all studding-sails, royals, and topgallant-sails; lat. 22° 30′, long. 66° 12′.

Hours	K.	F.	Courses.	Wind.	Remarks.
					7th April.
1	6		W.S.W.	E.N.E.	A heavy cross sea and blowing heavy,
2	6				ship rolling and straining a good
3	6				deal, besides shipping seas over all

Extracts from the Log of the KATHERINE STEWART FORBES (*cont.*)

Hours	K.	F.	Courses.	Winds.	Remarks.
					7th April (*continued*).
4	6				fore and aft a quantity of water went down the store-room scuttle into the cabin. Ship under sail according to the wind. At 8h. A.M., ship rolling awfully, and taking seas into the cabin through the doors. All the watch trying to keep the water from going down at aft, by baling, but of no avail; ship making water with us fast, starboard pumps of no use. At 4h. A.M., both the topsails went down out of the bolt ropes. At daylight, a tremendous gale or *hurricane* with a confused cross sea running at E. and S.E., stowed every sail except the foresail and scudded under it. At 10h., thick weather and rain; sounded the well at noon, and found ship making a great deal of water, all hands employed in baling water out of the cuddy, and the rest keeping the pumps agoing. Sun obscured.
5	6				
6	6				
7	6				
8	6				
9	6				
10	6				
11	6				
12	6		West.	East.	
1	6				
2	6				
3	6				
4	6				
5	6				
6	6				
7	6				
8	6				
9	6				
10	6				
11	6				
12	6				
					Lat. 22° 58′, long. 63° 40′, E.
					8th April.
1	3		West.	East.	A severe hurricane and a tremendous sea running, ship completely burying herself in the sea; found all her upperworks working. Examined and found all the stancheons gone short off by the covering board fore and aft; ship labouring awfully; could not heave the ship to for the sea for fear of clearing ship decks. At midnight, ditto weather: a sea struck us on the poop and carried away the gig and davits and bent the cutter's iron davit right up; smashed the poop skylight and donkey boom, and sent everything adrift on the poop. At 8h. A.M., held a consultation among the officers and men of the vessel about
2	4				
3	5				
4	5				
5	5				
6	5				
7	5				
8	5				
9	6				
10	6				
11	6				
12	6				
1	6				
2	6				
3	6				
4	6				
5	6				
6	6				

Extracts from the Log of the KATHERINE STEWART FORBES (*cont*).

Hours	K.	F.	Courses.	Wind.	Remarks.
7	7				8th April (*contiuued*). lightening her abaft, and were all of opinion that no time should be lost in doing so for the preservation of the ship and our lives. Commenced throwing articles overboard. Lat. 23° 30′, long. 60° 50′ E., per account.
8	7			S.E.	
9	7		Hove-to.		
10	1				
11	1				
12	1				

Note from Mr. Butterworth, second mate.

In the course of these twenty-four hours the wind gradually veered round south and S.S.W. At noon it was at S.W., when the ship was hove-to on the larboard tack, and gradually fell off to N.E. on the same tack all the time. The ship was on the larboard tack when the guns were thrown overboard.

Hours	K.	F.	Courses.	Wind.	Remarks.
1			N.W.	S.W.	9th April. Blowing furiously and an outrageous sea running, stowed foresail, and hove-to under main-trysail and fore-topmast - staysail. Still heaving cargo overboard and at the pumps. At 2h. P.M. a sea struck us and carried away all the stancheons and bulwarks fore and aft, taking with it eighteen water-casks of different sizes, starboard swinging-boom, pig-sty, three flour casks, gun-shot; two guns being adrift were obliged to throw them overboard, carried away all our bowsprit, bobstay, &c. People clearing the wreck and at the pumps. Got spars and ridge ropes fore and aft the side of the ship for safety. Seas going clear over us and quantities of water going below. Blowing a tremendous hurricane of wind. Got the bowsprit secured again,* all the ship's upper works completely adrift,
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12			N.E.	N.W.	
1					
2					
3					
4					
5					
6					
7					
8				West.	
9					
10					

---

* The vessel was kept before the wind for four hours while securing the bowsprit.

Extracts from the Log of the KATHERINE STEWART FORBES (*cont.*)

Hours	K.	F.	Courses.	Wind.	Remarks.
					10th April *continued*).
11					head-rails, bumpkins, and in fact all her topsides. At noon, ditto weather, all hands at the pumps or clearing away the wreck. Found the ship much more lively and making much less water; starboard pump useless. Lat. 23° 20′, long. 61° 30′.
12					
					10th April.
1			North.		At 1h. P.M., weather moderating. Set foresail and mizen to steady her. Ship still rolling and shipping quantities of water fore and aft; less wind. Split the mainsail and main-topgallant-sail during the gale. People at pump and securing things on deck. People living in the after cabin during the gale. Three pigs drowned, and three dozen fowls, &c. &c. Midnight, much finer, ship not making so much water, only pumped ship every four hours. Everybody's clothes wet fore and aft. At daylight, bent the best topsails and set them, also the jib and fore-topgallant-sail; repaired mainsail and set it; sent main-topgallant-sail down to repair it. Noon, weather clearing up, ship not making much water; sea going down; six seamen laid up sick through the weather. During the bad weather gave the ship's company grog four times a day. Lat. 22° 53′, long. 60° 4′.
2					
3					
4	3			N.N.W.	
5	4				
6	3				
7	3				
8	3				
9	3				
10	3				
11	3				
12	3				
1	3				
2	3				
3	3				
4	3				
5	3				
6	3				
7	3				
8	3				
9	3				
10	3				
11	3				
12	3				

On the 11th, 1 P.M., wind N. by W., course W. by N. 3 miles; 12, wind N.N.W., course west, 3 miles; 1 A.M., wind N.W., course west, 3 miles; 12, wind N.W., course W.S.W., 3 miles; fine weather but variable; *heavy swell* continues; wind light; lat. 23° 21′, long. 59° 38′ E.

On the 12th, 2 P.M., wind N.W., course W.S.W., 4 A.M., wind

Extracts from the Log of the KATHERINE STEWART FORBES (*cont.*)

west, course S.S.W., moderate weather, wind light and changeable. A swell. Lat. 24°, long. 58° 14′ E.

On the 13th, wind N.W., bore up for the Isle of France.

No. 13. ON THE DIAGRAMS.

Extracts from the Log of the ship FRAMJEE COWAJEE, *from Calcutta to Mauritius.*

27th March, 1843, wind S.E. to E.S.E., fine, lat. 10° 46′, long. 82° 41′.

On the 28th, wind S.E. and S.S.E., *heavy gales, constant rain, a confused sea running;* under double and treble-reefed topsails; lat. 12° 22′, long. 80° 41′ E.

On the 29th, wind S.S.E. to S.W., strong breezes, squally and thick hazy weather, lat. 13° 20′ S., long. 78° 20′ E.

On the 30th, wind S.W., west to N.W., occasional squalls, more moderate, lat. 14° 18′, long. 78° E.

On the 31st, wind N.W. to N.N.E., steady breezes, cloudy, a cross sea, lat. 15° 24′, long. 75° 41′ E.

1st April, wind N.E. by N., squally at times, reefs in the topsails, lat. 16° 7′, long. 72° 15′.

On the 2nd, wind N.N.E., threatening weather, hard squalls, three reefs in the topsails. A.M., moderating, lat. 16° 50′, long. 69° 9′ E.

On the 3rd, wind N.W., squally and unsettled weather, a heavy cross sea, ship pitching bows under, lat. 17° 18′, long. 66° 18′ E.

On the 4th, wind N.N.E., north, N.W., a strong gale, ship labouring heavily. Midnight, a continued succession of hard squalls and small rain. Noon, moderate, a "heavy cross confused sea." Lat. 18° 8′, long. 64° 10′.

On the 5th, wind N. by E. to N.N.W., moderate breezes, occasional squalls, but a very heavy cross sea running. Lat. 18° 50′ S., long. 63° 6′ E.

On the 6th, wind N.N.W., squally with rain, lat. 19° 10′, long. 61° 56′ E.

On the 7th, wind N.N.W., N.W., and W.S.W., light breeze and fair. Midnight, squally, small rain. 6 A.M., *taken aback with a squall from the southward;* "a very high sea from south *as if it had been blowing.*" Lat. 19° 42′, long. 60° 20′.

Extracts from the Log of the ship FRAMJEE COWAJEE (*continued*).

On the 8th, wind S.W., moderate with rain, lat. 18° 47′, long. 59° 12′ E.

On the 9th, wind S.W., clear and light breezes, lat. 18° 55′, long. 59° 12′ E.

On the 10th, wind N.N.W., fine weather, lat. 19° 42′, long. 59° 10′ E.

On the 11th, wind N.N.W., calm, lat. 20° 12′, long. 58° 28′ E.

NO. 14. ON THE DIAGRAMS.

Extracts from the Log of the SURAT MERCHANT.

April 1st, 1843, wind north, weather squally, lat. 15° 38′, long. 74° 13′ E.

On the 2nd, wind N.N.E. to N.W., squally with rain, lat. 16° 28′, long. 72° 41′.

On the 3rd, wind N.N.E. to N.N.W., wild unsettled weather, a heavy sea, squally with rain, occasionally fine, lat. 17° 22′, long. 70° 37′ E.

On the 4th, wind N.N.E., fresh breezes, fine. 8 P.M., a *confused sea*, lat. 17° 57′, long 68°.

On the 5th, wind north, breeze decreasing, a heavy head sea. Midnight, heavy rain, ship pitching, lat. 18° 31′, long. 65° 46′ E.

On the 7th, wind north to N.W. by W., a heavy southerly swell, squally with rain, a "confused heavy sea," lat. 19° 32′, long. 61° 51′.

On the 8th, wind W.S.W., west, W.N.W., fresh breezes, a heavy confused swell, the vessel pitching bows under. Midnight, a heavy head sea (S.S.W.). Noon, fresh breezes and clear weather, lat. 20° 3′ S., long. 61° 30′ E.

On the 9th, wind N.W. by W., fine weather but a heavy confused swell, lat. 19° 31′ S., long. 61° 11′ E.

On the 10th, wind W.N.W., N.N.W., a heavy head sea, moderate and fine, lat. 20° 10′, long. 60° 29′.

No. 10. on the Diagrams.

Extracts from the Log of the barque Waverley, *from Batavia to Rotterdam.*

(*Lost her Log-book in the gale.*)

Hours	K.	F.	Courses.	Wind.	Remarks.
1	6	6	W. by S.	East.	Wednesday, 5th April. P.M., commences with fresh breezes, and squally with showers, and a strong swell, ship rolling heavily, and shipping much water on deck. At 8h. P.M., same weather, in main-topgallant-sail. Midnight, ditto weather. At 6h., strong gales and squally with rain, furled the fore-topsail. At noon, gale increasing with a heavy sea, shipping much water over all; pumping ship every four hours. Lat. 21° 18′, long. 66° 19′, account. (Lat. 21° 28′, long. 62° 20′ E.)
2	7				
4	7				
6	7				
8	7				
10	7	2			
12	7				
1	7				
2	7				
4	7				
6	7				
8	7	2			
10	7	4			
12	7	4			
2	7	4	W.S.W.	E.S.E.	Thursday, 6th April. Strong gales and heavy squalls with a high sea, ship rolling heavily and shipping great quantities of water over all. Washed a quantity of the starboard bulwarks away. At 5h., gale increasing to a hurricane; in close reef of main-topsail and furled foresail. Hove-to under close-reefed main-topsail, ship lurching heavily, and taking in water. At 8h. the sea stove in a strong bulkhead in front of the poop made of three-inch deal, also destroyed a new topmast set sail with which it was covered. After which the sea swept away the cabin bulkheads, carpenter's, second mate's, and passengers' cabins, with the whole of their clothes, notwithstanding all our efforts to prevent it. At midnight, ditto weather.
4	7	4		E. by S.	
6	1	4	S. by E.		
8	1	4	toS.S.W.		
10	1	4			
12	1	4			
2	1	4			
4	1	4			
6	1	4			
8	1	4			
10	1	4			
12	1	4			

Extracts from the Log of the barque WAVERLEY (*continued*).

Hours	K.	F.	Courses.	Wind.	Remarks.
					Thursday, 6th April (*continued*). A.M., a great quantity of bulwarks gave on both sides. At 8h., more moderate. At noon, the gale considerably abated. Thick hazy weather, with rain; pumps going constantly. Lat. 21° 40′ S., long. 65° 20′ E., per account. Lat. 21° 40′ S., long. 61° 50′ E.
					Friday, 7th April.
1	5	4	W.S.W.	E. by S.	Fresh breezes and thick weather with constant rain; out close-reef of topsail and set the foresail. At 5h., ditto weather, second reef of main-topsail out. At 10h., the gale increased rapidly, the wind veering round the compass. Took in the foresail; washed away the hencoops, one studding-sail-boom, one topgallant-sail off the poop, and the jolly-boat from the quarter. Stove in the deadlights. At 11h., blowing a tremendous hurricane, took in the main-topsail and hove-to under bare poles on the larboard tacks. A.M., blowing a hurricane, with thunder, lightning, and rain; the starboard side being completely under water. The whole of the cabins washed away except the starboard aft one in which the sails were stowed, all the captain's and officers' clothes, a great quantity of cabin stores. About this time the log-book was washed away. At 5h., the ship down on her beam ends; cut away the foremast which carried away the main-mizen-topmast and jib-boom with it, and all their rigging. Also two topgallant-studding-sails from the maintop. The wreck damaging the mainsail, mizen, main-trysail, and gaff-topsail. The main-topmast stove in
2	5	4	"	"	
3	5	4			
4	5	4			
5	5	4			
6	6	4			
7	6	4			
8	6	4			
9	6	4			
10	7	4			
11	7	4			
12	1	4			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

Extracts from the Log of the barque WAVERLEY (*continued*).

Hours	K.	F.	Courses.	Wind.	Remarks.
					Friday, 7th April (*continued*). the quarter gallery in going astern. Cut away six casks of water, two of beef, two of pork, and two casks of hams from the starboard side, after which the ship righted considerably. At 8h., sounded the pump, found four feet of water in the hold. Lat. 22° 30′, long. 60° 40′.
2 4 6 8 10 12 2 4 6 8 10 12			Up W.N.W. off N.W.	S.W.	Saturday, 8th April. Strong gales and hazy weather, with rain, the ship lying very much on her side, from which we conjectured that the cargo had shifted; threw the starboard gun overboard; the decks constantly under water. Discovered the mizenmast to be sprung and the guard-board from the starboard side forward. At 9h. more moderate; ship labouring heavily and taking in immense quantities of water. A.M., fresh gales and cloudy with a heavy sea, threw about 540 bags of rice from the fore hatchway, mostly from the starboard side to endeavour to get the ship upright. Ends with strong winds and cloudy with a heavy swell. Pump constantly going. Lat. 21° 54′, long. 64° 10′ E., account. (Lat. 22° 20′, long. 60° 30′ E.)
2 4 6 8 10 12 2 4 6	0	4 4 4 4 4 4 4 4 4	Up W. NWbyN	W.S.W.	9th April. Fresh breeze and cloudy with a heavy swell, the sea constantly washing over the decks. Set the double-reefed mizen. At midnight, ditto weather. A.M., ditto weather, threw about 320 bags of rice from the after hatchway, mostly from the starboard side to higher the ship and bring her upright. Ends moderate and cloudy

Extracts from the Log of the barque WAVERLEY (*continued*).

Hours	K.	F.	Courses.	Wind.	Remarks.
					9th April (*continued*).
8		4			with a heavy swell, ship rolling
10		4			heavily and taking in much water
12		4			Found that we gained on the pump.
					Lat. 22°, long. 60° 20′ E.

10*th April.—See the* ROBIN GRAY'S *Log of the* 10*th.*

No. 11. ON THE DIAGRAMS.

Extracts from the Log of the PARLAND.

Date.	Wind.	Courses.	Lat.	Long.	Remarks.
April 4th	E.S.E.	W.S.W.	15°55′	78° 31′	Generally fine.
5th	E.N.E.		16°55′	76° 8′	Ditto.
6th	E.		17°15′	74° 15′	Light breezes.
7th	E.N.E.				Ditto, clear weather.
Night			17°57′	71° 49′	Strong breezes and rainy.
8th	E. by N.		18°34′	69° 37′	Moderate breezes.
9th	E.N.E.		19°19′	67° 50′	Light airs, heavy swell from S.E. during 24 hours.
10th	E.		19°22′	64° 28′	Fine weather.

No. 12. ON THE DIAGRAMS.

Extracts from the Log of the schooner WELLINGTON.

In the wake of the storm.

Date.	Wind.	Courses.	Lat.	Long.	Remarks.
April 8th	N.E. N. N.N.W.	S.S.W. „	19°25′ 65°30′		Squally with rain; moderate, at times changeable; a heavy head sea.

Extracts from the Log of the schooner WELLINGTON (*continued*).

Date.	Wind.	Courses.	Lat.	Long.	Remarks.
April 9th	N.N.W. N.W.		20°37′	64° 1′	Ditto weather and heavy head sea. Ship pitching greatly.
10th	N.W. N. W.N.W.		20°47′	62 28	Steady breezes and fine weather, carrying top-gallant sails.
11th	N.W. N. and N.E.		20°21′	61° 15′	Fine weather, carrying studding-sails.
12th	NWbyW		20°15′	60°	Fine weather.
13th	W.N.W. W.S.W.		20° 4′	59° 14′	Ditto.

No. 15. ON THE DIAGRAMS.

Extracts from the Log of the GAZELLE *from England to Mauritius.*

Date.	Wind .	Remarks.
March 30th	South.	Light winds and fair weather. Lat. 33° 19′, long. 56° 39′.
31st	Variable to N.E.	Lat. 32° 36′ S., 57° 50′ E.
April 1st	North. South.	Cloudy with rain, fresh breezes. Lat. 31° 2′ S., long. 59° 20′, account.
2nd	S.S.E.	Cloudy and strong breezes. Lat. 27° 55′, ob., long. 58° 45′ E.
3rd	S. by E.	Cloudy, heavy squalls, much rain, split the mainsail. Lat. 24° 46′ ob., long. 60°.
4th	South.	Squally, rainy, and cloudy. Lat. 22° S., long. 56° 26′ E.
5th	S. by W. S.S.W.	Heavy squalls, much rain, and under double-reefed topsails. Barometer fell to 29.25. Made Port Louis.

APPENDIX.

NOTE 1.

EXMOUTH'S HURRICANE, Page 91.

WHILE the preceding pages were in the course of publication, some new and valuable information has been received bearing on the same subject. Through the kindness of Captain M'Kerlie, of the Royal Engineers, who was stationed in Port Louis when the vessels which suffered from the effects of the *Exmouth* hurricane put in to refit, and collected a number of extracts from their logs, we are enabled to clear up some points which, in the first account of this storm, appeared to be doubtful or incomplete. It will now be seen, by the following notes, that it was of a vortical nature, and progressing very nearly in the usual direction, from N.E. to S.W., but with somewhat less velocity, and turning more to the southward than in others occurring at the height of the hurricane season. It would appear to have been an extensive circuit of wind, formed between the monsoon and trade, which, as it encroached on the latter, rapidly became contracted in the sphere of its action, and proportionably augmented in violence, so that when it passed lat. 20° or 21° S. it almost resembled an immense tornado, chiefly connected with the upper currents, and only embracing a very limited portion of the surface stratum, as indicated by unusually quick re-establishment of the S.E. trade-wind after the passage of the storm. These peculiarities might naturally be contemplated in hurricanes developed at the very close of the westerly monsoon, and when the S.E. trade has acquired the strength, permanency, and new position proper to the cold season; and, we believe, that that of the *Exmouth* is the very latest in the stormy season, which has visited the South Indian Ocean with any degree of severity or calamitous consequences.

It is too late to illustrate the course of this storm by diagrams, but any one who feels a keen interest in the subject may readily supply this deficiency, by projecting a series similar to that used in tracing out the Rodriguez gale of 1843, from the facts as arranged in the following order. We take the liberty of pointing out to our readers the probable positions of the centre of the circle on each successive day, according to our own calculations, at the same time leaving them full discretion to fix on others which may appear to be nearer the truth, as we only solicit a candid and unbiassed examination of the facts. Although there are a few glaring errors in the dead reckoning of the vessels, yet the result of the whole is sufficiently conclusive. The extracts from the log-book of the *Moscow* alone contain the table of daily courses and distances, and this is so far fortunate as she appears to have accompanied the gale for a week.

April 27th.—Focus in Lat. 11° 30′ S., Long. 83° E.

The *Exmouth*, in lat. 10° 40′, long. 77° 40′ E., a fresh gale at *south* to S.S.W.

The *Coronet*, in lat. 14° 56′, long. 87° 14′ E., wind at *east* to E.N.E., strong, squally, and accompanied by "heavy rain."

On this occasion the centre was evidently to the eastward of the *Exmouth* and northward of the *Coronet*.

April 28th.—Focus in Lat. 12° S., long. 81° E.

The *Exmouth*, in lat. 10° 34′ S., long. 77° 10′, the gale S.W. to *west*. See page 91.

The *Coronet*, in lat. 15° 12′ S., long. 85° 10, wind E.N.E., moderate trades, and showery.

The *Moscow*, about lat. 14° S., long. 80° E., a heavy S.S.E. gale.

The vortex appears to have been to the N.E. of the *Moscow*, and on a line between the *Exmouth* and *Coronet*.

April 29th.—Focus in Lat. 13° S., long. 79° E.

Exmouth, in lat. 11° 06′ S., long. 78° E., a westerly gale. See page 92.

Coronet, in lat. 15° 50′ S., long. 83° E., wind N.E., "strong, *with sharp squalls and a high sea, ship rolling excessively.*"

Extracts from the Log of the Moscow, *29th April*, 1840.

Hour.	K.	F.	Courses.	Wind.	Lee-way.	Remarks.
P.M.						
2	2	4	SW.byW.	S.S.E.		Strong gales and squally. At 2 P.M., in mainsail. At 10 P.M., in fore and main topsails.
4	2	4				
6	2	4				
8	2	4				
10	2	4				
12	1					
A.M.						
2	1					At 2 A.M., set close-reefed main topsail. At 5 A.M., set close-reefed fore topsail. Ends strong gales and rainy.
4	1					
6	2	4				
8	2	4				No observation.
10	2	4				Lat. 14° S.; long. 78° 15′ E.
12	2	4				

In this, the first extract from the *Moscow's* log, we discover that she was in a severe storm, of a circular kind, with the centre to the N.E. or in her wake, and between the *Exmouth* in the moonson and *Coronet* in the trade-wind.

April 30th.—Focus in Lat. 13° 30′, long. 77° E.

Exmouth, in lat. 11° 47′, long. 78° 25′ E., gale west to W.N.W. See page 92.

Coronet, in lat. 16° 40′ S., long. 80° 54′ E., a strong breeze at N.E.

Extracts from the Log of the American barque Moscow, *30th April,* 1840.

Hour.	K.	F.	Courses.	Wind.	Lee-way.	Remarks.
P.M.						
2	2	up	S.S.W.	S.E. by S.		Continues strong gales, and rainy. At 2 P.M., the gale increasing, took in the fore and main topsails and foresail; hove-to under the main spencer, and sent down the top-gallant yards.
4		off	SW.byW.			
6						
8		up	S.E. by S.	East.		
10		off	South.			
12						Through the night, heavy gales, squally, with a bad sea on. Carried away the bobstay; took until dark to secure it.
P.M.						
2		up	S.E.	E. by N.		
4		off	S. by E.			Ends heavy gales, and a bad sea on. Ship lying to easy, and making good weather of it.
6						
8		up	S.E. by E.	E.N.E.		
10		off	S.S.E.			No observations.
12						Lat. 15° 50′; long. 76° 45′. (*? too much westing.*)

The vortex would appear to have advanced to a line between the *Moscow* and *Exmouth*, and to the N.W. of the *Coronet*.

May 1st.—Focus in Lat. 14° 40′ S., Long. 75° 30′ E.

Exmouth, in lat. 11° 36′ S., long. 77° 10′ E., a fresh breeze at N.W. to N.N.E. See Log at page 92.

Coronet, in lat. 17° 20′ S., long. 79° 06′ E., a fine breeze at N.E.

Pacific, lat. 18° 36′ S., long. 81° 16′ E., a fine light breeze, N.E. and variable.

Extracts from the Log of the Moscow, *1st May,* 1840.

Hour.	K.	F.	Courses.	Wind.	Lee-way.	Remarks.
P.M.						
2		up	S.S.E.	N.E.	7	Continuing heavy gales and rainy, until 6 A.M., when, the weather getting better, kept off and made sail. Set foresail, single-reefed main topsail, and double-reefed fore topsail. At 10 A.M. sent the main top-gallant-yard aloft, and set the sail; sent the fore top-gallant-yard aloft, with appearance of better weather. Ends strong gales and squalls.
4		off	S.E. by S.			
6						
8						
10						
12						
A.M.						
2						
4						
6						
8	5	4	S.W.	NE.byN.		No observation.
10	6	4				Lat. 15° 7′ S.; long. 74° 42′ E. (*? too much westing.*)
12	6	4				

The vortex hitherto coming up with the *Moscow* appears to have overtaken her to-day, when she experienced that moderation which exists near the centre. Her course being S.W. kept her longer in the lull than had she been going in a contrary direction.

MAY 2ND.—FOCUS IN LAT. 15° 40′ S., LONG. 74° 30′ E.

Exmouth in lat. 14° 51′ S., long. 76° 40′ E., wind N.N.E. See page 92.

Coronet in lat. 17° 48′ S., long. 77° 33′ E., wind E. by N. to N.E.

Pacific in lat. 18° 58′ S., long. 82° 30′ E., wind N.E. to E., light. There seems to be something wrong in the reckoning of this vessel, as she was steering W. by S. all the twenty-four hours, and yet appears 60 miles more to the eastward than on the previous day. We call attention to this because the *Pacific* encountered the storm on the 5th, when her longitude would also seem to have been incorrect.

Extracts from the Log of the Moscow, *2nd May*, 1840.

Hour.	K.	F.	Courses.	Wind.	Lee-way.	Remarks.
P.M.						
2	6	4	SW. ½ W.	NE.byN.		Continuing strong gales and squally. At 8 P.M., heavy squalls; took in main top-gallant-sail and double-reefed main topsail. Through the night, strong gales and squally. At 6 A.M., more pleasant weather; let the reef out main topsail and set main top-gallant-sail. The fore top-gallant-sail, after being set a few minutes, carried away yard in the slings. At 8 A.M., heavy squalls; took in main top-gallant-sail, put one reef in main topsail, found main top-gallant-yard gone in the slings,—sent it down. Ends strong gales and squally. No observation. Lat. 17° S.; long. 72° 40′. (?)
4	6	4				
6	5					
8	7					
10	6					
12	6					
A.M.						
2	6	4				
4	6	4				
6	6	4				
8	6					
10	6					
12	6	4				

The *Moscow* could not have made two degrees of westing by her log on the 30th April, and on the 1st May her longitude was most likely 73° 40′ E. At all events the focus was not far from her, by the weather which she experienced.

MAY 3RD.—FOCUS IN LAT. 17° S., long. 73° 50′ E.

Exmouth in lat. 17° 57′ S., long. 75° 3′ E., wind N.E. See page 93.

Coronet in lat. 18° 32′ S., long. 75° 25′ E., wind N.E., freshening;

course W. by S., on this and the three previous days. Occasional squalls, "thick weather, the scud flying very fast over the ship."

Extracts from the Log of the Moscow, *3rd May,* 1840.

Hour.	K.	F.	Courses.	Wind.	Lee-way.	Remarks.
P.M.						
2	6	4	S.W.½W.	East.		This day commences with strong gales, and rainy. At 5 P.M., double-reefed the topsails; at 10 P.M., took in the fore, and double-reefed the main topsail. At 11 P.M., the ship steering very bad, took in the main topsail. At daylight, the sea and gale increasing and ship steering very wild, took in the foresail and hove-to under the main spencer; sent the hands aloft to put double gaskets on the yards, and get all snug for a blow. Ends heavy gales and high sea, but the ship making very good weather of it.
4	6	4				
6	6	4		E. by S.		
8	5	4				
10	5					
12	5					
A.M.						
2	5					
4	5					
6		up	S. by E.			
8		off	S. by W.			
10						
12						
	100 miles.					No observation for five or six days. Lat. 18° S.; long. 72° or 72° 40′ E.

The *Moscow* is seen to have the same weather accompanying her to the S.W.; but her longitude could not have been more than 71° 40′ E., and the wind from east to E.S.E, having the focus to the N.N.E.

MAY 4TH.—FOCUS IN LAT. 18° 30′ S., LONG. 73° 30′ E.

The *Exmouth* in lat. 18° 30′ S., long. 73° 20′ E. The hurricane from E.N.E. to S.S.E., and was at the edge of the focus about noon. See page 94.

The *Coronet* seems to have been in lat. 18° 48′ S., long. 74° E. On this day the hurricane swept over her, "veering N.N.E., north, N.W., to west." With her the gale—

> Commenced at 3 A.M., and blew very hard till 6 A.M. At 8 A.M. wind shifted to the northward, and blew a hurricane until 4 P.M., with a tremendous high sea. Lost head-rails, quarter-boats, bulwarks, and the sails were blown from the yards when furled, &c. In fact, we expected to founder. 6 P.M., moderating; 8 P.M., set a close-reefed main-topsail and main-trysail. Was hove-to great part of the time. The hurricane did not shift suddenly, but gradually veered round the compass.

The *Pacific,* in lat. 19° 58′ S., long. 78° E., (?) also had the wind veering E.N.E. to N.E. and N.W. Her longitude evidently incorrect.

Extract from the Log of the American Barque Moscow. (Wind S.W.)

4TH MAY.—Commences with heavy gales and a large sea. Lee bulwarks washing away. At 2 P.M. the stern boat washed away. At 3 P.M. a very sudden and violent hurricane, which hove the ship on her beam-ends. At

3 h. 30 m. P.M., the lower yards being half under the water and the ship leaking at her stern frame and upper works, we found our only hope, to prevent the ship from foundering (she being almost completely under water, and still settling down), was to cut away the topmasts, which carried away the heads of the three masts, jib-boom, and head of bowsprit, and fore and main tops, &c. At 7 P.M. succeeded in getting the wreck of the spars from alongside. At 10 P.M. the hurricane continued with increased violence. Towards morning the gale gradually abating. As the vessel righted, the leaks diminished. The gale commenced at east and moderated at S.W., veering by the south point. The sea seemed to strike the ship four points more to the northward than the west. Lat. 17° 54′ S., long. 70° 40′ E.

The focus appears to have passed between the *Coronet* and the *Moscow*, and directly over the *Exmouth*, veering from E.N.E. by N. to N.W. and west with the first, and by east S.E. to S.W. with the second, and proves what was suspected, that it was a rotatory and progressive storm, conforming to others in the same latitude, but, owing to the season, more limited and brief in its duration, as next day all the vessels had moderate weather.

Hitherto the storm has been traced along a path from N.E. to S.W. and S.S.W. Next day, however, there are some very doubtful signs of its path having been due south, but the only grounds for such a surmise are the imperfect and, in some points, manifestly erroneous extracts from the log of the *Pacific*, which vessel appears to have been considerably to the westward of her dead reckoning. One remark has already been made which justifies this opinion, and as her courses, winds, and distances are not included in the extracts, there are no means of thoroughly ascertaining her real positions. However, we here advert to the possibility of this storm moving as supposed, or rather of having been carried as a tornado by the upper N.W. current across the trade wind, and, perhaps, as being the termination of hurricanes which close the tempestuous months of the South Indian Ocean; because it involves points of practical importance, even although such can only be rare and exceptional cases.

5TH MAY, 1840.

The *Exmouth*, not far from her position of the previous day, had the weather moderating and the wind noted S.E., but as she was without a rudder, and drifting W.N.W., it was most likely more to the eastward.

The *Coronet* in lat. 18° 40′ S., long. 73° 40′ E., had a moderate S.E. breeze.

The *Moscow* in lat. 17° 59′ S., long. 69° 13′ E., had the wind S.W. to south, and veering to S.E., and moderate.

Extracts from the Log of the PACIFIC, *5th May*, 1840.

At 3 P.M. took in all the studding sails. The wind shifted to N.E.; by 7 P.M. it blew hard at N.E.; steering before the wind, and all sails furled except the foresail and main-topsail. About 9 P.M. the main-topsails blew away; it was blowing with great violence; the sails blown from the gaskets. At 11 the quarter-boats were washed away. At midnight the wind shifted to N.N.W., and blew with such violence as to lay the ship on her beam-ends. The topmasts with all above went over the side. The ship not offering to righten, cut away one of the shrouds of the mizen-mast, and it went immediately over the side. About 2 A.M. it moderated. At day-light moderate breezes at south. Lat. 20° S.

The *Pacific* had been steering W. by S. on the 4th, and for twelve hours on this day she was steering before the gale, or a S.W. course, by which she ran into the east side of the vortex, and had the wind veering from N.E. to N.N.W., showing its rotation in accordance with other storms. She had the focus bearing S.W., how far off it is difficult to say, perhaps thirty, sixty, or even ninety miles. By this vessel's own account, she could not have been more than in long. 76° W., but there is strong reason to think that she was two or three degrees further west. Another palpable mistake occurs in her log; for on the 4th her latitude was 19° 58′ S.; yet although she scudded twelve hours before a N.E. storm (100 miles?), her latitude next day indicates only two miles of southing! Also refer to the 2nd May. Ships in the tract of the S.E. are always carried more westward by currents than their dead reckoning. It is, however, impossible to define the spot where the *Pacific* met with this gale, but it is quite clear she was running S.W.

The other *three* vessels all furnish concurrent evidence of its course from N.E. to S.W. for several days, and the *two* gales of the *Exmouth* are actually demonstrated to have been one and the same, by the log of the *Moscow*, which vessel, in running SW. by W. for six days, appears to have been near its vortex from lat. 14° S., long. 80° E., to lat. 18° S., long. 70° E. Another fact is equally clear, that all the four ships were running W.S.W. and S.W.; and like those in the first storm which has been noticed in this work, they apparently overtook the same storm which had passed them in its early and more rapid progression.

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NOTE II.

MAURITIUS HURRICANE OF APRIL, 1840.—PAGE 107.

The following extracts* from the log of the ship *Patriot* throws additional light on the path by which the storm approached the island.

On the 8th April this vessel was approaching the Mauritius from the eastward, with heavy increasing gales at E. by S. (magnetic variation 14°); with rain, hard squalls, and a heavy confused sea running. Was under double-reefed topsails, and labouring greatly from the swell. Saw Round Island, at the N.E. end of Mauritius, at 10 A.M. The sea is said to have been rising and easterly; and, as the vessel got under the lee of the N.W. side of the island, it was a smooth sea when the anchors were let go at the Bell buoy, off Port Louis.

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* Received from Captain M'Kerlie, of the Royal Engineers.

On the 9th the weather got worse. The royal and top-gallant-masts were struck, and 100 fathoms of cable veered out, and other preparations for a hurricane were made. At noon strong gales and very heavy squalls, with incessant rain. The storm blowing at S.E. by E. to E.S.E. * * * At 8 P.M. very heavy gales; ship driving to seaward; riding, but in the heavy gusts of wind from 9 to 12 P.M. the ship drove.

On the 10th, at 1 h. 50 m. A.M., drove off the bank into deep water; the ship broached-to and fell over on her beam-ends, with the starboard side of the top-gallant forecastle and main deck under water. Cut away the mainmast for the preservation of the ship, and in its fall carried away the mizen-mast head. Immediately the masts and wreck were clear of the ship, she righted. At 4 A.M. the gale abated a little. At daylight *calm*, with a heavy confused sea. At 8 A.M. a light S.W. air. A breeze at 11 A.M., gradually increasing; stood to the south-westward, and saw several swamped boats. At noon, strong *south-west gales*. In consequence of having lost her main and mizen-masts, the ship could not be hove-to, but fell off almost before the wind. At 1 P.M. strong gales from N.W., and increased to a hurricane. At 1 h. 30 m. P.M. saw the land and breakers about a mile to leeward; cut away the foremast, and let go the starboard anchor in five fathoms water, and veered out sixty fathoms of chain. Ship driving on the breakers and a tremendous sea running. At 2 A.M. the ship struck abaft, at the same time the sea making a breach over her bows, and washing everything off the deck. At 4 P.M. the ship broke about the main hatchway, the fore part drooping a great deal. At 7 P.M. less sea, and the gale abated.

The vessel held together till next day, when the weather was so moderate as to enable boats to communicate with her. Had she been aware of the nature of the gale, and, after she drifted off the bank, had run N.W. with the S.E. part of the gale, she would have had room to have lain-to and to drift back with the N.W. half of the vortex. By her log we perceive how well the circular theory is borne out by referring her position to Diagram 16 Plate VII., constructed and engraved before we obtained her log. It will therein be seen that by drifting from Port Louis she was at the west side of the circle, and at the edge of the calm, keeping in it six hours by running S.W. along the coast, and experienced the wind veering from S.E. by S.W. to N.W. At Mahébourg, on the S.E. (and *opposite*) side of the island, the gale was observed by Dr. Cotton of the 12th regiment to veer from "east by N.N.E. to W.N.W., with torrents of horizontal rain," from 6 A.M. till 3 P.M. on the 10th April, at the time when the *Patriot* was drifting on the reefs at the N.W. coast.

The following extract from observations made at the French Observatory at Bourbon, 128 miles from Port Louis, is given literally; and although the remarks are more in the form of a summary, than a daily detail, they show that the focus passed to the east of that island, and the barometer was at its lowest range till the 11th, or twenty-four hours later than at Mauritius, clearly determining the line along which the centre of minimum depression was moving.

TABLE G.

A Table *of Barometric Observations made at the Observatory in the Island of Bourbon, during the Hurricane of April,* 1840.

Avril 1840.	Heure.	Baromètrique Observé.	Thermo. Centigrade du Barom.	Hygromètre.	Observations.
7me	6 du M.	759.05	26° 0′	90°	Du premier Avril au 5 inclus les vents ont regnè du S.S.E. en le rapprochant du sud, la mer était dure au large belle à terre. Le 6 le vent de S.S.E. très fort jour et nuit; la mer très grosse. La communication difficile avec la terre, et interdite le 7. Rade de marée très fort qui dure jusqu'au 11. On n'a point observé au port la direction de la houle. Mais il parait qu'elle n'a pas été différente de ce qu'elle est avec le vent de S.S.E. Le vent, toujours très fort, souvent par raffales a dure jour et nuit jusqu'au 9, ou il a tourné subitement au sud, au S.O., à l'O., au Nord, et au N.E. dans la même journée. Le 10, le vent d'abord a l'est est devenu N.O. et O.N.O., menaçant, l'ordre d'appareiller a été donné aux navires en rade; mais des le lendemain plusieurs batiments sont revenus au mouillage. Les vents sont notes à l'ouest, N.O.; jusqu'au 15me ou a regnè la brise regulière du S.E. En general, le temps qu'il a fait à Bourbon, quoique menaçant n'etait pas de nature à faire soup, conner le grave disastre eprouvé à Maurice à la même époque. Il n'a point été fait d'observation sur l'electricité de l'atmosphere ni sur l'aiguille aimantée.
	3 du S.	758.10	27° 0′	74°	
8me	6 du M.	757.80	26° 0′	97°	
	3 du M.	756.30	28° 1′	82°	
9me	6 du M.	756.35	26° 1′	85°	
	9 du M.	756.85	26° 2′	87°	
	3 du S.	755.50	28° 3′	68°	
	9 du S.	756.70	27° 6′		
10me	3½ du M.	754.70	26° 0′		
	6 du M.	754.50	26° 1′	89°	
	9 du M.	754.75	26° 0′	93°	
	3 du S.	752.00	27° 0′	84°	
	6 du S.	752.50	27° 0′		
	9 du S.	753.25	27° 0′		
11me	3 du M.	753.05	26° 5′		
	6 du M.	753.10	25° 6′	90°	
	9 du M.	753.65	26° 0′	87°	
	3 du S.	753.70	29° 0′	78°	
	9 du S.	756.50	27° 8′		
12me	3½ du M.	756.80	27° 0′		
	6 du M.	757.55	27° 0′	91°	
	9 du S.	758.90	27° 0′	88°	

NOTE III.

Mauritius Hurricane of December, 1844.

The following note informs us of the passage of another hurricane near Mauritius, and the case of the *Stag* may be useful to other vessels, when caught in one of these at the anchorage of Port Louis.

Extracts from the Log of the Ship Stag, Captain W. H. Young.

Dec. 15, 1844.—Steering W. by S., 10 miles per hour; wind, E.S.E. to S.E. Strong gales, constant rain, with a high sea. Ship at first under close-reefed topsails, and latterly close-reefed. Lat. ob. 16° 10′ S.; long. 67° 56′ E. Run 245 miles S. 73° W.

Dec. 16.—Course W.S.W.; wind S.E.; blowing hard, with passing squalls. Fore topsail handed. Lat. 17° 13′ S.; long. 64° 24′ E. Course S. 73° W.; 213 miles.

Dec. 17.—Course S. 66° W.; 192 miles. Wind S.E. to S.S.E.; strong gales and passing squalls.

Dec. 18.—Course W.S.W.; 242 miles. Wind S.E. by E.; strong gales and squally. At 2 p.m., anchored at the Bell buoy, at Port Louis, in Mauritius. Midnight, blowing hard.

Dec. 19.—Wind E.S.E. to east; blowing hard, with rain; heavy gusts of wind from the land. 4 p.m., let go the second anchor. Noon, blowing heavy, with hard gusts or whirlwinds passing (blowing off the high land). The barometer falling, and every appearance of the wind *shifting to the* N.W., as there is a swell from that quarter. The ship slipped from her anchors and put to sea.

Dec. 20.—Blowing furiously; ship scudding W.S.W., under the fore-sail, with the wind at east. At 3 a.m., hove-to under bare poles, heading to N.N.W. Blowing hard; continued gusts, with constant rain, and the sea running very high. At 1 p.m., the gig washed away from the quarter; wore ship, with her head to S.S.E. All night it blew in continued fierce gusts, with constant rain.

Dec. 21.—Wind N.E.; blowing heavy, with high sea. At noon, lat. 21° 36′ S.; long. 56° 50′ E. Course from Friday, S. by E.; 100 miles.

Dec. 22.—Wind, north-easterly; weather moderating. Lat. 22° 9′ S.; long. 58° E.

As in other cases, the *Stag* seems to have had the vortex of this storm following her from the N.E.; but being a fast sailer, she kept in front of it till she anchored at Port Louis, when it came up with her. She appears to have acted right by slipping from her cables and running south of the island, and laying her head to the S.E., as the direction of the hurricane, and its veering to N.E., showed that the focus was passing westward of the island, and it would have been more judicious if she had done so in the first instance, instead of going W.S.W. But had the gale been veering from S.E. by south to S.W., she would have been wrong, as N.W. would in such a case have been the proper direction to run.

NOTE IV.

HURRICANE AT DORRE ISLAND, LAT. 25° S., LONG. 113° W.

From the little that is known of the N.W. part of New Holland, there is reason to conclude that it is especially subject to rotatory gales, obeying the same laws as those which have been the subject of inquiry in this volume. That of the *Maguasha* is the only one in detail which we have been able to collect; but from perusal of Captain Grey's interesting account of his expeditions for discovering this coast, information is gathered which would render it probable that during the hot months of the year, a succession of stormy portions of atmosphere, in gyration, drift along the coast. There is no mistake whatever about the nature of one storm experienced by Captain Grey having been of this kind, as shown by the following brief extracts.* On Feb. 26th, at Bernier's Island, in the mouth of Sharks' Bay—

> The wind (says Captain Grey) had freshened considerably about daylight, and throughout the day it blew nearly a gale from the S.E.; it *now looked so foul* that I feared a long period of bad weather was about to commence.
>
> FEB. 27th.—This morning it still blew nearly a gale of wind from the S.E.

By the "violence of the surf," one of Captain Gray's boats was dashed on the beach, and went to pieces in a few moments. The wind appears to have freshened rapidly during the evening and night, and was accompanied by "heavy squalls" and "rain from all quarters; much thunder and lightning."

FEB. 28th.—The wind moderated, so as to enable the party to pull along the shore of the island, with a heavy head sea (S. by E.). At 3 P.M. they reached Dorre Island and—

> Found a most convenient little boat-harbour, sheltered by a reef from all winds. To the eastward, the waters of the bay were tossed wildly to and fro, as if by a coming storm, yet the wind had fallen perceptibly, and the only alarming sign was the peculiar look of the sky. * * At 11 o'clock at night it was blowing a terrific gale of wind, which increased every moment in a most extraordinary manner; the wind was from the S.E., and the breakers came pouring over the reef, as if the bay was going to empty bodily all its waters into the little cove in which the boats were anchored.

It ought to be remembered that this tremendous surf was not from the open ocean, but from Sharks' Bay, and the wind was off the land. A description of the horrors of that night is given in a graphic manner by Captain Grey; and all who have ever been in a hurricane will recognise a scene that is seldom forgotten. On this occasion many of the party were perfectly appalled by the hurricane, never having seen anything of the kind before. The vivid flashes of lightning which accompanied the storm added additional grandeur to the war of elements.

On the 1st March, about dawn—

> The storm appeared *to lull* a little, and in a few minutes (about half-past 5 A.M.) it *suddenly dropped*.

---

* Journals of two expeditions of discovery in North-west and Western Australia, &c., by the Hon. Capt. Grey.—p. 334.

Fruitless attempts were made to communicate with the boat still riding on the agitated waters of the cove, and some time was thus spent,—how long we cannot make out, but

> Just as the last man had failed, *the wind, which had hitherto been from the* S.E., *shifted instantaneously to the* N.W. We all quailed or fell before it, for it came with sudden and indescribable violence; the boat appeared to hesitate for one moment, in the next she came dancing wildly in on the shore. The men reached her as well as they could, and we dragged her up. The storm now became so violent that even Mr. Walker, who was a heavy man, was blown about like a child; there was not a tree on the island, but the bushes were stripped from the ground, and I found it impossible to keep my legs.

At 2 P.M. the storm lulled considerably, and appears gradually to have subsided in the usual manner.

As in the Mauritius gales, the wind was S.E., and after a lull chopped round to N.W.; it was about three days in passing, from the commencement of the S.E. gale, by which we may judge of the slow progression and magnitude of the revolving disc of air. It came from the eastward, or N.E., and passed over the continent of New Holland, as Captain Grey informs us that after the storm he

> *Found the shores of Dorre Island covered with great forest trees,* which must have been washed across the bay, and which, from their size, could only have been *brought out from the continent* by some large and rapid stream.

Thus on the east side of the Indian Ocean a hurricane is found moving from N.E. to S.W., *from* a vast continent to the open ocean; and on the opposite, or western side, others have been traced to follow the same direction, but travelling across Madagascar and *towards* the continent of Africa. While continuing his expedition along the N.W. coast of New Holland, during the rest of March, Captain Grey had several other gales veering from S.E. to S.W., and from the heavy sea which appears to have been experienced along with them, we infer that N.W. winds blowing on the coast must also have prevailed.

Captain Stokes, of H. M. ship the *Beagle*, was at Port Essington during a severe hurricane, which happened in November, 1839; and as this gentleman is now publishing an account of the discoveries made on this coast, we may expect some information on this important question.

NOTE V.

A HURRICANE NEAR TAHITI.

In December, 1842, H. M. ship, the *Favourite*, on her way from Tahiti to the Island of Mangea, met with a storm of a rotative kind, and so severe that the vessel was hove-to under a main-trysail. Ample warning was given of its approach by the gradual fall of the barometer. The officer in command (Captain Sullivan) was warned on his departure from Tahiti, that he would certainly be overtaken by a hurricane before he reached his destination. This fact shows that storms of this kind are so familiar to the inhabitants of the island, that they are able to foretell their approach for some days before they set in.

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